BEAR® 33
VOLUME VENTILATOR
MAINTENANCE MANUAL

Bear Medical by Allied

PREFACE

PROPRIETARY INFORMATION

INFORMATION CONTAINED WITHIN THIS MAINTENANCE MANUAL IS PROPRIETARY TO BEAR MEDICAL SYSTEMS, INC., AND MAY BE USED ONLY FOR THE PURPOSE OF PROVIDING MAINTENANCE. THE PURCHASE, RECEIPT OR POSSESSION OF THIS MAINTENANCE MANUAL DOES NOT CONFER, TRANSFER OR LICENSE ANY OTHER RIGHTS IN THIS INFORMATION. ANY OTHER USE OR DISCLOSURE AND/OR REPRODUCTION (by any method) OF THE INFORMATION CONTAINED HEREIN IS PROHIBITED UNLESS EXPRESSLY PERMITTED HEREIN.

INTRODUCTION

The BEAR® 33 Volume Ventilator Maintenance Manual contains electrical and mechanical verification, calibration, troubleshooting and replacement instructions prepared to assist a qualified bio-medical technician in the maintenance of the ventilator.

The Maintenance Manual is specifically intended for use by an authorized service person. Any adjustments or procedures that exceed the scope of this manual should be referred to a Bear Medical Systems Factory Service Center. For specific operating instructions and clinical theory of operation, refer to the BEAR® 33 Ventilator Clinical Instruction Manual (P/N 50000-10133). Maintenance personnel should become thoroughly familiar with the Operating and Repair techniques before servicing this equipment.

Page Numbering

The page numbering system used throughout this manual is as follows:

Page 0-0 •

The first digit, left of the hyphen indicates the section of the manual. The second digit(s) right of the hyphen is the sequential page number within the section.

• November 1984

The month-year following the page number is the revision level of the individual page. When a page(s) has been revised, the month and year will be updated. Where no change has occurred, the month and year will remain unchanged even though the page may have been reprinted in the revision process.

50000-12066

This is the part number of the base manual or component.

NOTE

Section 3 will have a different part number as it was prepared as an individual document. It does interrelate to the basic maintenance manual.

BEAR MEDICAL SYSTEMS, INC.
STANDARD WARRANTY

Bear Medical Systems, Inc. standard warranty is extended to the original buyer purchasing the equipment directly from Bear Medical Systems, Inc. or through its authorized dealers. All warranty periods, where applicable, commence on the date of first purchase but not more than six months after shipment from Bear Medical Systems, Inc. Bear Medical Systems' sole obligation and liability under this warranty is limited to (at Bear Medical Systems option) the repair or replacement by Bear Medical Systems authorized personnel of any parts or assemblies which, upon test and examination by Bear Medical Systems prove to be defective. This equipment may be returned prepaid to Bear Medical Systems after prior notification has been given and approval obtained for the return.

This warranty does not cover normal maintenance such as cleaning, adjustment, or lubrication and updating of equipment or parts thereof. This warranty shall be void and not apply if the equipment, including any of its parts, is modified without Bear Medical Systems authorization, is attempted to be repaired by personnel not authorized by Bear Medical Systems, is not maintained in accordance with the prescribed schedule, is used with accessories or parts not authorized, or is damaged due to misuse, mishandling, abuse, negligence, accident, fire or inadequate packaging by owner for shipment. Bear Medical Systems makes no guarantee of clinical results.

2

THE WARRANTY STATED ABOVE (INCLUDING ITS LIMITATIONS) IS THE ONLY WARRANTY MADE BY BEAR MEDICAL SYSTEMS AND IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. BEAR MEDICAL SYSTEMS SHALL NOT BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES OF ANY KIND.

Warranty period is one year with the following exceptions:

1. Preventive maintenance (90 days) and overhaul (180 days) warranty on all parts and labor included in all procedures.
2. Batteries are specifically excluded from warranty.

WARNINGS, CAUTIONS AND NOTES DEFINED

WARNING

Means there is a possibility of personal injury or death to yourself or others.

CAUTION

Means there is a possibility of damage to the instrument or other property.

NOTE

Indicates significant points to be aware of.

THE FOLLOWING GENERAL WARNINGS AND CAUTIONS MUST BE READ AND UNDERSTOOD PRIOR TO PERFORMING ANY OF THE TESTS, REPAIRS OR OTHER PROCEDURES IN THIS SERVICE MANUAL.

GENERAL WARNINGS

- UNDER NO CIRCUMSTANCES SHOULD THIS MEDICAL DEVICE BE OPERATED IN THE PRESENCE OF FLAMMABLE ANESTHETICS OR OTHER VOLATILE MATERIALS DUE TO A POSSIBLE EXPLOSION HAZARD.
- LIQUID SPILLED OR DRIPPED INTO THE UNIT MAY CAUSE DAMAGE TO THE UNIT OR RESULT IN AN ELECTRICAL SHOCK HAZARD.
- OXYGEN VIGOROUSLY ACCELERATES COMBUSTION. DO NOT USE ANY GAUGES, VALVES OR OTHER EQUIPMENT THAT HAS BEEN EXPOSED TO OIL OR GREASE CONTAMINATION TO AVOID VIOLENT IGNITION.
- DO NOT DISPOSE OF THE INTERNAL SEALED LEAD ACID BATTERY BY INCINERATION AS IT MAY EXPLODE WHEN EXPOSED TO FLAME.
- DO NOT RELEASE THIS MEDICAL DEVICE IF ANY ALARM/ALERT FUNCTION IS INOPERATIVE. TO DO SO COULD RESULT IN A MALFUNCTION WITHOUT WARNING, POSSIBLY RESULTING IN PERSONAL INJURY, DEATH, AND/OR PROPERTY DAMAGE. REFER THE UNIT TO A BEAR MEDICAL SYSTEMS AUTHORIZED SERVICE TECHNICIAN OR A BEAR MEDICAL SYSTEMS TRAINED HOSPITAL SERVICE TECHNICIAN.
- WHEN VERIFYING THE OPERATION OF THIS MEDICAL DEVICE, DO NOT BREATHE DIRECTLY FROM THE MACHINE. ALWAYS USE A FRESH BACTERIAL FILTER AND TEST CIRCUIT. A HAZARD TO THE HEALTH OF THE SERVICE PERSON MAY RESULT.
- ALL TUBING AND FITTINGS USED TO CONNECT HIGH PRESSURE GAS (AIR AND OXYGEN) FROM THE SOURCE TO TEST EQUIPMENT, AND FROM THE TEST EQUIPMENT TO THE DEVICE, MUST BE CAPABLE OF WITHSTANDING A SUPPLY PRESSURE OF 100 PSI (7.03 kg/cm^2). THE USE OF TUBING AND FITTINGS NOT CAPABLE OF WITHSTANDING THIS PRESSURE COULD CAUSE THE TUBING TO RUPTURE, RESULTING IN PERSONAL INJURY OR PROPERTY DAMAGE.
- DO NOT ATTEMPT TO CHARGE THE INTERNAL BATTERY WITH ANY OTHER CHARGER THAN THE ONE CONTAINED IN THE VENTILATOR AS THE BATTERY MAY EXPLODE OR BECOME DAMAGED.
- DISCONNECT ALL ELECTRICAL POWER, AIR AND OXYGEN SOURCES BEFORE ATTEMPTING ANY DISASSEMBLY. FAILURE TO DO SO COULD RESULT IN INJURY TO THE SERVICE TECHNICIAN AND/OR EQUIPMENT.

GENERAL WARNINGS, continued

- THIS MEDICAL DEVICE SHOULD NEVER BE SERVICED OR THE COVERS REMOVED WHEN CONNECTED TO A PATIENT. INTERNAL MAINTENANCE MAY AFFECT THE OPERATION OF THE UNIT, JEOPARDIZING PATIENT CARE.
- DO NOT USE TEFLON™ TAPE IN PLACE OF PIPE SEALANT. SHARP THREADS MAY SHRED THE TAPE AND THE FIBERS COULD CLOG CRITICAL ORIFICES, RESULTING IN POSSIBLE PATIENT INJURY OR DEATH.
- THE OPERATIONAL VERIFICATION PROCEDURES IN SECTION 3 AND CALIBRATION PROCEDURES IN SECTION 5 MUST BE COMPLETED WHEN ANY PART OR ASSEMBLY HAS BEEN REMOVED AND/OR REPLACED. FAILURE TO DO SO COULD RESULT IN MALFUNCTION OF THIS MEDICAL DEVICE AND/OR INJURY OR DEATH TO THE PATIENT.
- HAZARDOUS VOLTAGES EXIST WITHIN THIS MEDICAL DEVICE. ALWAYS OBSERVE APPROPRIATE SAFETY PRECAUTIONS WHEN WORKING ON THE UNIT WHILE THE MACHINE IS CONNECTED TO AN ELECTRICAL POWER SOURCE TO PREVENT POSSIBLE ACCIDENTAL INJURIOUS ELECTRICAL SHOCK.
- USE EXTREME CARE WHEN SOLDERING TO PREVENT SOLDER SPLASHES, DAMAGE TO CONNECTORS, SOLDER BRIDGES (SOLDER CONNECTIONS BETWEEN TWO TERMINAL POINTS OR TO GROUND), OR POSSIBLE SHORT CIRCUITS DUE TO BURNED WIRE INSULATION. ANY OF THESE CONDITIONS COULD CAUSE VENTILATOR FAILURE, RESULTING IN POSSIBLE INJURY OR DEATH TO THE PATIENT.

The following CAUTIONS must be read and understood before performing any of the procedures in this service manual.

CAUTIONS

- *Do not use MEK or Tricloroethylene, as damage to surfaces may result. Do not allow any liquid to spill or drip into the ventilator.*
- *Do not gas sterilize the ventilator, the internal materials are not compatible with gas sterilization techniques.*
- *Do not overheat wiring or components when applying heat to heat-shrink tubing. Equipment damage could result.*
- *Do not use tape to insulate the joints. Tape can deteriorate and come loose.*
- *Before using any test equipment (electronic or pneumatic) for calibration procedures (other than operational verification), the accuracy of the instruments must be certified by a testing laboratory. The laboratory master test instruments must be traceable to the US Bureau of Standards or equivalent. When variances exist between the indicated and actual values, the calibration curves (provided for each instrument by the testing laboratory) must be used to establish the actual correct values. This certification procedures should be performed at least once every six months. More frequent certification may be required based on usage and environment.*
- *The circuit boards are subject to damage by static electricity. Do not touch components, circuit, or connector fingers with hands. Handle only by edges.*

5

GLOSSARY OF ABBREVIATIONS AND DEFINITIONS

A	Ampere
amp	Ampere
AC	Alternating Current
BATT	Battery
BPM	Breaths Per Minute
cc	Cubic Centimeters
cm	Centimeter
cmH$_2$O	Centimeter of Water Pressure
°C	Degrees Centigrade
db	Decibel
DC	Direct Current
°F	Degrees Fahrenheit
EtO	Ethylene Oxide
EXT	External
FDA	Food and Drug Administration
FIO$_2$	Fractional Concentration of Inspired Oxygen
Hz	Hertz
ID	Internal Diameter
I:E	Inspiratory Time to Expiratory Time Ratio
INT	Internal
INOP	Inoperative
kg	Kilogram
lb	Pound
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPM	Liters Per Minute
ml	Milliliter
msec	Millisecond
µsec	Microsecond
O$_2$	Oxygen
PEEP	Positive End Expiratory Pressure
PRESS	Pressure
PIP	Peak Inspiratory Pressure
PVC	Polyvinylchloride
PWR	Power
R.H.	Relative Humidity
SIMV	Synchronous Intermittent Mandatory Ventilation
Solenoid	Electrically Controlled Valve
t	Time
T$_I$	Inspiratory Time
U.L.	Underwriter's Laboratories
VAC	Volts Alternating Current
VDC	Volts Direct Current
VENT	Ventilator
V$_T$	Tidal Volume
<	Less than
>	Greater than

TABLE OF CONTENTS

Preface ... i-i
Proprietary Information ... i-i
Introduction ... i-i
Page Numberings ... i-i
Standard Warranty ... i-i
Warnings, Cautions and Notes Defined ... i-iii
General Warnings ... i-iii
Cautions ... i-iv
Glossary of Abbreviations and Definitions ... i-v

Section 1 Specifications, Technical Data ... 1-1
Section 2 Theory of Operation ... 2-1
Section 3 Operational Verification Procedure ... 3-1
Section 4 Partial Disassembly ... 4-1
Section 5 Calibration and Verification ... 5-1
Section 6 Schematics ... 6-1
Section 7 Troubleshooting ... 7-1
Section 8 Removal and Replacement Procedures ... 8-1
Section 9 Preventive Maintenance ... 9-1
Section 10 Spare Parts ... 10-1
Section 11 Repacking and Shipping Instructions ... 11-1

INDEX

Section 1 Specifications, Technical Data ... 1-1
  General Description ... 1-1
  General Specifications ... 1-1
  Performance Specifications ... 1-1
  Control Mode ... 1-1
  Assist-Control Mode ... 1-1
  SIMV Mode ... 1-2
  Functional Controls ... 1-2
  Mode Control ... 1-2
  Tidal Volume Control ... 1-2
  Rate Control ... 1-3
  Sigh Control ... 1-3
  Assist Sensitivity Control ... 1-3
  Peak Flow Control ... 1-3
  ON/OFF Button ... 1-3
  Alarm Silence ... 1-3
  Alarm Loudness Control ... 1-3
  High Pressure Alarm Control ... 1-3
  Low Pressure Alarm Control ... 1-3
  Visual Reset Control ... 1-3
  Panel Unlock Control ... 1-3
  Test Button ... 1-3
  UP/DOWN Buttons ... 1-4
  Functional Control Limits ... 1-4
  High Pressure Alarm ... 1-4
  Low Pressure Alarm ... 1-5
  Apnea Alarm ... 1-5
  Ventilator Inoperative Alarm ... 1-5
  Low Battery Alarm ... 1-5
  Power Change Alarm ... 1-5
  Complete Power Failure Alarm ... 1-5
  Displays ... 1-6
    Tidal Volume ... 1-6
    Rate ... 1-6
    Peak Flow ... 1-6
    Assist Sensitivity ... 1-6
    Hi Press ... 1-6
    Lo Press ... 1-6
    Inspiratory Time ... 1-6
  Operational Indicators (Table 1-3) ... 1-6
  Alarm Indicators (Table 1-4) ... 1-6
  Gauges and Meters (Table 1-5) ... 1-6
  Functional Inputs and Outputs ... 1-7
    Electrical Inputs to Ventilator ... 1-7
    Patient Circuit Connections ... 1-7
    Pressure Relief Port ... 1-7
    Gas Inlet ... 1-7
    Remote Alarm Output Jack ... 1-7
    Case Vent ... 1-7
  Miscellaneous ... 1-7
    Filters ... 1-7
    Overpressure Relief Valve ... 1-7
    Circuit Breaker ... 1-7
    Default Program ... 1-7
    Default Parameters ... 1-7
    Cold Start ... 1-7
  Product Accessories ... 1-7
    Patient Circuit ... 1-7
    Humidifier ... 1-7
    Battery Cables ... 1-8
    One Way Valve ... 1-8
    PEEP Valve ... 1-8
    Humidifier Mount ... 1-8
    Oxygen Accumulator ... 1-8
    Table 1-6 Specifications ... 1-8
Section 2 Theory of Operation ... 2-1
  Electronic System ... 2-1
  Interaction Between Modules ... 2-1
  Monitor Interface ... 2-1
  Central Processor ... 2-1
  Electronic Block Diagram ... 2-2, 2-3
  Reset/Clock Fail System ... 2-4
  Power ON/OFF Circuit ... 2-4
  LED Drivers ... 2-5
  LCD Display Drivers ... 2-5
  Pressure Transducer System ... 2-6
  Analog-to-Digital Converter ... 2-6
  Controller System ... 2-7
  Central Processor ... 2-7

Position/Direction Logic 2-8
Motor Drive 2-8
Servo Loop 2-8
Power Switching 2-9
External Battery Charger Circuit 2-10
Solenoid Drivers 2-10
INOP Logic 2-11
Audible Alarm 2-11
Motor Driver Module 2-12
Display Module 2-12
Sensor Module 2-13
Pneumatic Diagram 2-14
Pneumatics 2-15
Normal Tidal Volume Delivery 2-16
Tidal Volume with PEEP 2-16
SIGH Volume Delivery 2-16
Spontaneous Breathing 2-17
Spontaneous Breathing with PEEP 2-17
High Pressure Alarms and Limit 2-17
Overpressure Relief Valve 2-17
Pressure Relief Port 2-18
Section 3 Operational Verification Procedure 3-1
Introduction 3-1
Verification Program 3-1
Test Equipment Required 3-1
Warnings 3-2
Cautions 3-2
Cleaning and Inspection 3-3
Patient Circuit 3-3
Filters 3-3
Plugs and Cables 3-3
Filter Replacement 3-4
Standard Settings 3-5
Set-up Procedure 3-5
Standard OVP Test Circuit 3-6
Display and Alarm Test 3-7
Power-up Test 3-8
System Leak Test 3-9
Control Mode Test 3-10
Assist Control Mode Test 3-11
SIMV Test 3-12
Tidal Volume Display Function Test 3-14
Rate Test 3-15
Peak Flow Display Function Test 3-16
Assist Sensitivity Display Function Test 3-17
Sigh Function Test 3-17
Proximal Airway Pressure Gauge Test 3-18
High Pressure Alarm and Apnea Alarm 3-19
Low Pressure Alarm and Apnea Alarm 3-20
Delivered Volume Test 3-21
Overpressure Relief Valve Test 3-22
Operational Verification Checklist 3-23
Checklist Sign-off 3-24
Section 4 Partial Disassembly 4-1
Section 5 Calibration and Verification 5-1
Introduction 5-1
General Procedure 5-1
Equipment Required 5-1
Standard Test Circuit 5-3
Proximal Pressure Gauge Verification 5-3
Pressure Gauge Test Circuit 5-4
Disassembly and Visual Inspection 5-5
Electrical Tests 5-6
Default Parameter Verification 5-6
Power Supply Verification 5-8
Controller PCB Test Points 5-8
Power Supply Voltage Tables 5-9
Power Supply Priority Alarms and Monitors – Threshold Tables 5-9
Display Control Verification 5-11
Delivered Volume, Rate, Flow and Assist Specifications Table 5-11
Monitor ADC Reference Voltage Calibration 5-12
Pressure Transducer Verification and Calibration 5-12
Section 6 Schematics 6-1

General

Pneumatic Diagram 6-2
Pneumatic Schematic 6-3
Electronic Block Diagram 6-4
Electronic Wiring Diagram 6-5

PCB Layouts

Sensor PCB and Motor PCB 6-6
Display PCB 6-7
Monitor PCB 6-8
Controller PCB 6-9

Electronic Schematic Diagrams

Sensor PCB 6-11
Display PCB 6-12
Monitor PCB ....6-13 to 6-16
Controller PCB ....6-17 to 6-20
Motor PCB 6-21
Section 7 Troubleshooting 7-1
Warnings 7-1
Cautions 7-2
Electronic Block Diagram 7-3
Power Supply Troubleshooting Chart 7-4
Rate Troubleshooting Chart 7-4
Volume Troubleshooting Chart 7-5
Alarm Troubleshooting Chart 7-5
Home Sensor Test 7-6
Heartbeat Detector 7-6
Motor Current Test 7-6
Section 8 Removal and Replacement Procedures 8-1
Bridge Rectifier 8-1
Internal Battery 8-2
Circuit Breaker 8-3
Filter Capacitor 8-4
Power Transformer 8-4

Drive Belt....................8-6
Patient Air Inlet Filter....................8-7
Alarm Speaker....................8-8
Controller PCB....................8-9
Monitor PCB....................8-10
Pressure Gauge....................8-11
Display PCB....................8-12
Front Panel....................8-13
Sensor PCB....................8-14
Motor PCB....................8-14
Battery Level Indicator....................8-15
Pump Module Assembly....................8-15
EXH/Prox Fittings....................8-16
Terminal Block....................8-17
Unlock Switch....................8-18
Section 9 Preventive Maintenance....................9-1
Recommended Service Procedure....................9-1
Preventive Maintenance Parts....................9-1
Equipment Required....................9-1
Exterior Inspection....................9-1
Ground Resistance....................9-2
Current Leakage....................9-2
Interior Inspection....................9-2
Preventive Maintenance Kit Installation....................9-2
Pump Cleaning and Lubrication....................9-2
Internal Battery Check....................9-2
Pneumatic Verification and Calibration....................9-2
Electronic Verification and Calibration....................9-2
Preventive Maintenance Checklist....................9-3
Section 10 Spare Parts....................10-1
Parts List....................10-1
Illustrated Parts....................10-2 to 10-13
Section 11 Repacking and Shipping Instructions11-1

9

BEAR® 33 Volume Ventilator

Maintenance Manual

Part Number 50000-12066

Bear Medical by Allied

Allied Healthcare Products, Inc.
Ventilation Products Division
2085 Rustin Avenue
Riverside, CA 92507-2437 USA
Phone (909) 788-2460
(800) 232-7633
FAX (909) 351-4609

For Europe and Africa,
please contact:
Allied Healthcare Products AG
Zugerstrasse 74, CH-6340 Baar
Switzerland
Phone 41-42-318155
FAX 41-42-318158

©1990 Bear Medical Systems, Inc.

SERIAL # 887

WARNING

THIS SERVICE MANUAL IS INTENDED FOR USE BY BEAR MEDICAL SYSTEMS, INC. TRAINED AND AUTHORIZED SERVICE PERSONNEL.

BEAR MEDICAL SYSTEMS, INC. DOES NOT CONDONE OR APPROVE OF SERVICE ACTIVITY ON ITS PRODUCTS BY OTHER THAN BEAR MEDICAL SYSTEMS, INC. TRAINED AND AUTHORIZED PERSONNEL; AND, BEAR MEDICAL SYSTEMS, INC IS NOT RESPONSIBLE FOR ANY UNAUTHORIZED REPAIRS, OR ANY REPAIRS MADE BY UNAUTHORIZED PROCEDURES.

USE OF THE INCORRECT PART–OR FAILURE TO EXERCISE DUE CARE IN THE INSTALLATION, REMOVAL, SERVICING, CHECKOUT OR CALIBRATION OF PARTS AND EQUIPMENT–MAY RESULT IN DAMAGE TO THE EQUIPMENT AND POSSIBLE MALFUNCTION OF THE EQUIPMENT WHICH MAY IN TURN RESULT IN DAMAGE TO PROPERTY AND INJURY (INCLUDING DEATH) TO PERSONS. THE PURCHASER AND INSTALLER OF THESE PARTS SHALL BEAR FULL RESPONSIBILITY AND LIABILITY FOR THE ABOVE.

ALL MAINTENANCE PERFORMED WITHIN THE APPLICABLE WARRANTY PERIOD (SEE WARRANTY CARD) MUST BE AUTHORIZED IN ADVANCE BY A BEAR MEDICAL SYSTEMS, INC. SERVICE REPRESENTATIVE IN ORDER TO RETAIN THE WARRANTY STATUS OF THE SUBJECT UNIT.

SECTION 1

BEAR® 33 VOLUME VENTILATOR SPECIFICATIONS AND TECHNICAL DATA

GENERAL DESCRIPTION

The BEAR® 33 Ventilator is a volume ventilator for use with adults and larger children. It is designed for use in both the hospital and home setting.

This ventilator provides three modes of ventilation: Control, Assist-Control and SIMV. There are four primary controls for setting ventilation parameters: Tidal Volume, Rate, Peak Flow and Assist Sensitivity. PEEP is accomplished with an optional expiratory PEEP valve.

GENERAL SPECIFICATIONS

Physical

Overall Dimensions

Height	7.5 inches	(19.2 cm)
Width	14 inches	(35.8 cm)
Depth	11.6 inches	(28.2 cm)
Weight	32 lbs	(14.5 kg)

Power

United Stated Input Voltages		
	120 VAC (96-132)	60 Hz
International Input Voltages		
	100 VAC (80-110)	50/60 Hz
	220 VAC (176-242)	50/60 Hz
	240 VAC (192-264)	50 Hz
All uses	12 VDC (12-15)	

Power Cord

AC
Length: 10 ft
Connector: US, Hospital Grade

DC
External 12 VDC Battery
Length: 8 ft
Connector: Ring lug
External 12 VDC with automobile cigarette lighter adapter
Length: 8 ft
Connector: Automobile cigarette lighter adapter

Circuit Breakers

Domestic	120 VAC	1.5 A
International	100 VAC	2.0 A
	220 VAC	0.8 A
	240 VAC	0.8 A

Gas Supply Requirements

Oxygen, USP Medical Grade

ENVIRONMENTAL

Temperature

Storage:	-30° to +160°F
Operating Ambient:	32° to 120°F

Altitude	12,000 feet maximum
Humidity	0 to 99% R.H., non-condensing

CLEANING

Wipe external surfaces with dry or alcohol-moistened cloth. Finish will withstand non-abrasive home cleaners.

STERILIZATION

Sterilization of the ventilator is not recommended. Refer to the BEAR® 33 Instruction Manual for sterilization procedures for patient circuit and accessories.

PERFORMANCE SPECIFICATIONS

Modes

The ventilator has three modes of operations: Control, Assist-Control and SIMV.

Control Mode

The ventilator delivers gas to the patient at the preset TIDAL VOLUME, PEAK FLOW and RATE. In the CONTROL mode, ASSIST SENSITIVITY is not operational; however, the display can be set. The patient may still draw spontaneous breaths through the ventilator in the CONTROL mode.

Assist-Control Mode

In the ASSIST-CONTROL mode, when the patient effort goes below the preset sensitivity level, the ventilator assists by delivering a machine-generated breath. The effort required to initiate an assisted breath is determined by the ASSIST-SENSITIVITY Control Setting. The volume and inspiratory time of the assisted breath are the same as for a controlled breath. The patient can take shallow, spontaneous (unassisted) breaths through the ventilator valving as

12

long as the negative, patient-induced pressure is insufficient to trigger an assist response from the ventilator. Assisted breaths can occur at rates exceeding the RATE Control setting. If no assisted breath occurs within the breath-to-breath time interval as set by the RATE setting, the ventilator will automatically deliver a controlled breath.

SIMV Mode

In the SIMV mode, the ventilator assures that a preset minimum volume and rate are delivered but still allows the patient to breathe spontaneously between machine cycles. Periodically, (at breath-to-breath intervals determined by the RATE Control setting) an Assist Window is generated by the ventilator. During the Assist Window time period, the ventilator will deliver an assisted breath (as in ASSIST-CONTROL mode) in response to the patient's attempt to inhale. An assisted breath closes the Assist Window for that time period. If no assisted breath occurs within the breath-to-breath interval determined by the RATE control, the ventilator will automatically deliver a controlled breath. Under this condition, the Assist Window remains open indefinitely until an assisted breath occurs and controlled breaths are delivered at the preset rate. The patient can breathe spontaneously at any flow level when the Assist Window is closed and can take shallow, spontaneous breaths at pressure levels insufficient to trigger an assist when the window is open. When PEEP is added to the patient circuit, the patient must be capable of reducing the baseline pressure to the cracking pressure of the cylinder bypass check valve in order to spontaneously breathe. The cylinder bypass check valve cracks at -0.2 cmH₂O. PEEP may lead to increased work of breathing, and may be beyond the capabilities of some patients. Thus, it is important to evaluate the need for PEEP in light of the patient's ability to perform work of breathing.

FUNCTIONAL CONTROLS (See Figure 1-1)

Mode Control

Button that selects one of the three modes: Control, Assist-Control or SIMV.

Tidal Volume Control

Determines the tidal volume to be delivered to the patient circuit.
Range: 100 cc to 2200 cc in 10 cc increments.
Accuracy: 5% of setting or 20 cc, whichever is greater.

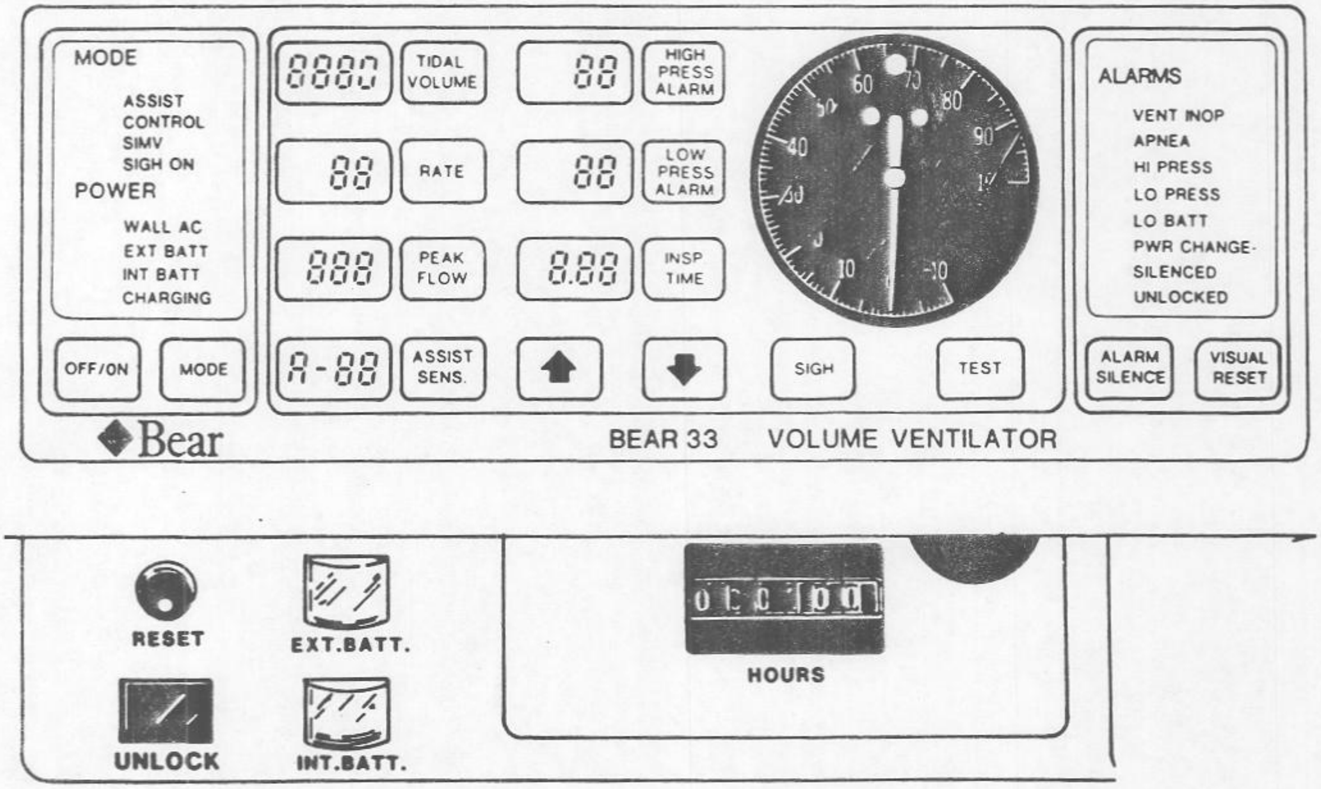

MODE
ASSIST
CONTROL
SIMV
SIGH ON
POWER
WALL AC
EXT BATT
INT BATT
CHARGING
OFF/ON
MODE
8880
TIDAL VOLUME
88
RATE
888
PEAK FLOW
A-88
ASSIST SENS.
88
HIGH PRESS ALARM
88
LOW PRESS ALARM
8.88
INSP TIME
SIGH
TEST
ALARMS
VENT INOP
APNEA
HI PRESS
LO PRESS
LO BATT
PWR CHANGE
SILENCED
UNLOCKED
ALARM SILENCE
VISUAL RESET
Bear
BEAR 33 VOLUME VENTILATOR
RESET
EXT.BATT.
UNLOCK
INT.BATT.
HOURS

Figure 1-1 • FUNCTIONAL CONTROLS

Rate Control

Sets the minimum number of machine breaths per minute initiated by ventilator or patient effort.

Range: 2.0 to 40 BPM

1.0 to 10 BPM in 0.5 increments
10 to 40 BPM in 1.0 increments

Accuracy: 5% of setting or 1 BPM, whichever is greater.

SIGH

An ON/OFF function. ON results in six sighs per hour. Sigh volume is defined as 1.5 times the normal tidal volume or 3000 cc, whichever is less. Sigh is active in all modes.

Range: 150 to 3000 cc

Accuracy: 5% of setting or 30 cc, whichever is greater.

Assist Sensitivity Control

Sets the threshold of patient effort required for an assisted breath at the proximal airway.This parameter can be set in all modes, but is not operational in the CONTROL mode.

When the patient pressure goes below the ASSIST SENSITIVITY setting, the letter "A" flashes at the left side of the ASSIST SENSITIVITY display.

Range: -9 to 19 cmH$_2$O in 1 cmH$_2$O increments

Accuracy: 2.0 cmH$_2$O

Peak Flow Control

Sets the peak flow delivered to the patient circuit in a sinusoidal waveform.

Range: 20 to 120 LPM in 1 LPM increments

Accuracy: 10% of setting

ON/OFF Button

This button activates any of the power sources being used (AC/DC) and is protected against accidental deactivation by an automatic panel lock mechanism.

Alarm Silence

A button to silence audible alarms (except VENT INOP) for a fixed time period.

Range: 60 seconds fixed

Accuracy: 1.0 second

Alarm Loudness

Range: 85 db fixed (at 10 cm)

Accuracy: 5 db

High Pressure Alarm Control

This control sets the high pressure alarm level which, if exceeded, also activates the inspiratory pressure relief valve.

Range: 0 to 80 cmH$_2$O in 1 cmH$_2$O increments

Accuracy: 0 to 65 cmH$_2$O - ±2 cmH$_2$O
65 to 80 cmH$_2$O - ±3 cmH$_2$O

Low Pressure Alarm Control

This control sets the low pressure alarm level.

Range: 3 to 70 cmH$_2$O in 1 cmH$_2$O increments

Accuracy: 3 to 65 cmH$_2$O ±2 cmH$_2$O
65 to 70 cmH$_2$O ±3 cmH$_2$O

Visual Reset

A button which resets latched alarm indicators. Visual reset is inhibited while an alarm condition exists. Depression of the VISUAL RESET silences the audible alarm portion of the POWER CHANGE alarm.

Panel Unlock

A button which unlocks the control panel functions for the following:

- Mode
- Tidal Volume
- Rate
- Peak Flow
- Assist Sensitivity
- SIGH
- High Pressure
- Low Pressure
- Power (OFF Only)
- UP
- DOWN

The panel will unlock for a time window of 15 seconds and will remain unlocked for 15 seconds from the last key stroke on the above listed buttons. To lock the panel during the 15 second window, depress the UNLOCK button again.

Test Button

A button which activates all display segments, indicators and the audible alarm. To activate TEST, the button must be depressed and held down.This process does not affect the ongoing delivery of breaths to the patient. When the BEAR® 33 Ventilator is first turned ON and the TEST button is depressed, the checksum value of the Monitor EPROM will be displayed on the TIDAL VOLUME display (3 digits) and HIGH PRESSURE alarm display (2 digits). All other displays will be blank. When the button is released, the display will go back to normal operation. This checksum indicates the revision level of the complete software package with the BEAR® 33 Ventilator (Monitor EPROM and Controller EPROM).

NOTE

For revision control, each time the software is changed, the checksum displayed must also be changed.

UP/DOWN Buttons

These two buttons allow the operator to increase or decrease the digital display settings of the following:

- Tidal Volume
- Rate
- Peak Flow
- Assist Sensitivity
- High Pressure Alarm
- Low Pressure Alarm

Each parameter is selected by its own control button. The desired parameter button must be held down while the appropriate UP or DOWN button is depressed. When the desired setting is shown on the digital display, release both buttons.

The breath delivered to the patient at any time is based upon the control settings at the beginning of that breath.

Functional Control Limits

Interaction of the controls throughout their specified ranges cannot set up combinations that are beyond the capabilities of the ventilator.

Maximum T_I = 4.99 seconds
Minimum T_I = 0.25 seconds

TIDAL VOLUME, RATE and PEAK FLOW may not be set to cause an inverse I:E ratio. Minimum T_E = 0.75 seconds in ASSIST CONTROL and SIMV.

When the TIDAL VOLUME, RATE or PEAK FLOW is adjusted, the individual parameter may not be adjusted to a setting which violates any of the above listed criteria.

When an attempt is made to set the parameter where the desired parameter setting will cause a violation of the predefined inspiratory time or I:E ratio limits, the parameter display and inspiratory time display will flash for as long as it and the UP or DOWN button are depressed. Table 1-1 overviews all possible occurrences.

In addition, a parameter cannot be set outside of its specification range. Once the range limit is reached, the display will flash. Table 1-2 overviews all possible occurrences.

Table 1-1

Parameter Being Adjusted	Functional Control Boundary	Flashing Display(s)
Tidal Volume	TI=0.25 TI=4.99 I:E Ratio<1:1	Tidal Volume and Inspiratory Time
Rate	TI=0.25 TI=4.99 I:E Ratio <1:1	Rate and Inspiratory Time
Peak Flow	TI=0.25 TI=4.99 I:E Ratio <1:1	Peak Flow and Inspiratory Time

Table 1-2

Parameter Being Adjusted	Parameter Specification Range	Flashing Display
Tidal Volume	100 to 2200 cc	Tidal Volume
Rate	2 to 40 BPM	Rate
Peak Flow	20 to 120 LPM	Peak Flow
Assist Sens	-9 to 19 cmH_2O	Assist Sens

ALARMS

High Pressure Limit Alarm

Visual and audible indication that the patient peak pressure has exceeded the high pressure setting. On the first positive pressure breath which exceeds the HIGH PRESSURE ALARM level, the following occurs:

a. Volume delivery is terminated
b. Pressure Limit Solenoid Valve is opened
c. Patient Exhalation Balloon is opened by (b) and patient pressure is relieved to atmosphere
d. The visual indicator, HI PRESS, is illuminated and flashing
e. The ventilator resets for delivery of next mechanical breath

If the second or successive positive pressure breath exceeds the HIGH PRESSURE ALARM limit, the following occurs:

a. Volume delivery is terminated
b. Pressure Limit Solenoid Valve is opened
c. Patient Exhalation Balloon is opened by (b) and patient pressure is relieved to atmosphere
d. The visual indicator, HI PRESS, continues to flash, is latched on, and must be manually reset with the VISUAL RESET button

e. An audible alarm will sound
f. The ventilator resets for delivery of next mechanical breath

If the second or successive positive pressure breath is normal (does not exceed limit), then the audible alarm will discontinue and the indicator will turn off.

Low Pressure Alarm
Visual and audible indication of low pressure condition. If the inspiratory patient pressure fails to transition through (low to high) the LOW PRESSURE ALARM setting on a machine delivered breath, the visual indicator will flash. If the second positive pressure breath transitions through the low pressure setting, the flashing visual indicator will terminate. If the inspiratory patient pressure fails to transition through the LOW PRESSURE alarm setting on a second successive breath, the audible alarm will sound and the flashing visual indicator will latch on. The audible alarm will cease on the next positive pressure breath which transitions through the LOW PRESSURE alarm setting.

Apnea Alarm
This alarm has a fixed period of 20 seconds. If the breath interval between any mechanical or spontaneous breath which is detected by the ASSIST SENSITIVITY function exceeds 20 seconds, the audible and visual alarm will activate. The audible alarm automatically cancels at the next breath. The visual indicator must be manually reset with the VISUAL RESET button.

Ventilator Inoperative alarm
This is an audible and visual alarm which indicates one of the following conditions:

a. FAILURE TO CYCLE – A condition which occurs after the ventilator has attempted its default program (see Default Parameters).
b. MONITORED PARAMETERS ERROR – Rate, Inspiratory Time or Tidal Volume are out of tolerance.
c. TIMING CIRCUIT FAILURE – If the master clock that controls both microprocessors fails or shifts, the clock attempts to reset itself (once). If reset is unsuccessful, the VENT INOP alarm is activated.
d. INTERNAL POWER SUPPLY FAILURE –A condition which occurs if any of the regulated voltages within the unit shifts beyond the acceptable limits.
e. ROM CHECKSUM ERROR – ROM error is detected on Power-up (on Monitor and/or Control PCB).
f. MONITOR/CONTROLLER COMMUNICATION ERROR – Communication error or break between the two PCBs.
g. RAM ERROR
h. HOME TIMEOUT – Motor is not driving piston HOME.
i. INTERNAL BATTERY POWER INSUFFICIENT TO DRIVE VENTILATOR – The internal battery is discharged beyond its ability to drive the pump.

The audible and visual alarms cannot be silenced or reset until the specific VENT INOP condition is corrected.

Low Battery Alarm
When the internal battery has 25% or less (0 to 15 minutes) operating time left, the audible and visual alarms will occur. The audible alarm will silence and the flashing indicator will go out automatically if the battery charge goes above 25% operating time. The visual indicator reset is inhibited while an alarm condition exists.

If the internal battery is the power source being used by the ventilator, the audible alarm may only be silenced for 60 seconds with the ALARM SILENCE button.

If either the external battery or wall plug is used as a power source for the ventilator, the audible alarm may be cancelled with the ALARM SILENCE button.

Power Change Alarm
This audible and visual alarm indicates that the ventilator has automatically switched power source under the following conditions:

a. AC Wall to External Battery
b. AC Wall to Internal Battery
c. External Battery to Internal Battery

This will cause an audible and visual alarm indication. The audible alarm will automatically cancel upon restoration of a higher power source. The VISUAL RESET button will cancel both the visual and audible alarm indicators.

Complete Power Failure Alarm
If all of the power sources fail (wall AC, external battery, internal battery), then the unit's built-in capacitor will activate the audible alarm for a minimum of one minute. Alarm loudness will diminish as the capacitor's power is depleted and there will be no indicator lights (panel will be completely blank).

16

DISPLAYS

Tidal Volume

Displays the TIDAL VOLUME control setting (4 digits).

Rate

Displays the RATE control setting (2 digits)

Peak Flow

Displays the PEAK FLOW control setting (3 digits)

Assist Sensitivity

Displays the ASSIST SENSITIVITY control setting (2 digits)

Hi Press

Displays the HIGH PRESSURE Alarm setting (2 digits)

Table 1-3
Operational Indicators

Operational Indicator	Color	Description
WALL AC	Green	Indicates WALL AC is powering the ventilator
EXT BATT	Green	Indicates EXTERNAL BATTERY is powering the ventilator
INT BATT	Yellow	Indicates INTERNAL BATTERY is powering the ventilator
CONTROL	Green	Ventilator is operating in the CONTROL mode
ASSIST CONTROL	Green	Ventilator is operating in the ASSIST CONTROL mode. The ASSIST portion of this display will blink off momentarily when an assisted breath is being delivered
SIMV	Green	Ventilator is operating in the SIMV mode. The ASSIST portion of the ASSIST CONTROL indicator will blink off momentarily when an assisted breath is delivered in SIMV
SIGH ON	Green	Indicates ventilator is delivering SIGH in the operating mode. This indicator blinks off for the duration of a sigh inspiration
CHARGING	Green	Indicates the charging circuit is operating
Ventilator ON	Green	Indicates the ventilator is turned ON

Lo Press

Displays the LOW PRESSURE Alarm setting (2 digits)

Inspiratory Time

Displays the calculated INSPIRATORY TIME (3 digits). This value is determined by the PEAK FLOW and TIDAL VOLUME controls.

Table 1-4
Alarm Indicators

Operational Indicator	Color	Description
VENT INOP	Red	Indicates a VENTILATOR INOPERATIVE condition exists
APNEA	Red	Indicates occurrence of a 20-second apneic period
HI PRESS	Red	Indicates HIGH PRESSURE Alarm setting is violated
LO PRESS	Red	Indicates LOW PRESSURE Alarm setting is violated
LOW BATT	Red	Less than 25% of internal battery power is available
PWR CHANGED	Yellow	Indicates an automatic change in power source has ocurred
SILENCED	Yellow	Indicates an audible alarm has been silenced for 60 seconds
UNLOCKED	Yellow	Indicates the control panel is unlocked

Table 1-5
Gauges and Meters

Gauges and Meters	Description
PRESSURE GAUGE	Displays patient proximal airway pressures from -10 to 100 cmH2O
HOUR METER	Displays the number of ventilator operating hours 0-99,999.9 hours (6-digit). Displayed resolution = 1 hour, actual resolution = 6 minutes. Must not lose more than 6 minutes for each ON/OFF
INT BATT CHARGE METER	Indicates the status of charge on the internal battery when operating on internal battery (not charging)
EXT BATT CHARGE METER	Indicates the status of charge on the external battery when operating on external battery (not charging)

FUNCTIONAL INPUTS AND OUTPUTS

Electrical Inputs to Ventilator

See General Specifications

Patient Circuit Connections

a. PATIENT CIRCUIT OUTPUT – A 22mm front panel fitting for the patient circuit
b. EXHALATION BALLOON OUTPUT – A 1/8" connector which drives the exhalation balloon.
c. PROXIMAL PRESSURE INPUT – A front panel connector which allows hookup of the 3/16" proximal pressure sensing line

Pressure Relief Port

A port connected to the output of the two pressure relief valves. It ensures the cabinet interior does not receive increased FIO_2

Gas Inlet

A 27mm tapered female gas inlet port to cylinder. The tapered port allows connection of an external oxygen accumulator. Oxygen input to the accumulator may come from a pressurized O_2 source or an oxygen concentrator. Patient FIO_2 is documented with an external O_2 monitor.

Remote Alarm Output Jack

This output is activated by an alarm condition and provides an electrical signal to drive a remote (optional) alarm with a 40 ft signal cable.

Case Vent

Removable door fitted with a 70-micron filter

MISCELLANEOUS

Filters

There is a 70-micron filter at the gas inlet, accessible for daily cleaning. Older units have an additional 70-micron filter in the case vent, also easily accessed for daily cleaning.

Overpressure Relief Valve

This is a mechanical backup relief valve on the inspiratory leg of the patient circuit.
Range: 85-125 cmH$_2$O

Circuit Breaker

A 1.0 ampere circuit breaker is located in the AC power line.

Default Program

The BEAR® 33 Ventilator microprocessor is protected in a number of ways from power surges and electromagnetic interference. One of these is a default program which guards against total loss of memory.

The following conditions will activate the DEFAULT program:

1. TIDAL VOLUME – ±30% of setting
2. RATE – ±30% of setting
3. RAM ERROR – Random Access Memory lost
4. INSPIRATORY TIME – ≤.65: ±50%; >.65: ±30%
5. MONITOR REGISTER OVERFLOW

Default Parameters

If any of the conditions listed above is detected, the processor will attempt to reestablish the set parameters. If it fails to do so, on the next attempted breath the ventilator will automatically switch to the default parameters. They are:

RATE	16 BPM
VOLUME	500cc
FLOW	35 LPM
HI PRESS	40 cmH$_2$O
LO PRESS	10 cmH$_2$O
MODE	ASSIST CONTROL
ASSIST SENSITIVITY	-1 cmH$_2$O

When the ventilator displays the DEFAULT PARAMETERS, an audible alarm will sound and all the control displays will flash in rotation. During default, all the alarm indicators are still operational.

To reset, the ventilator panel must be unlocked and the ventilator turned OFF. When the ventilator is turned back ON, the default parameters will appear in the displays. The ventilator panel can then be unlocked and setup with the desired parameters.

Cold Start

If all sources of power are lost (AC, External DC, Internal DC), the controls will automatically come up with the default parameters listed above when power is reapplied to the ventilator.

PRODUCT ACCESSORIES

Patient Circuit

The patient circuit may be sterilized and is reusable. The ventilator end of the circuit is arranged so that hookup can be accomplished with or without a humidifier in the circuit. Individual connectors are minimized and standard ANSI slip fits are used.

Humidifier

The ventilator interfaces with the BEAR® LS 420/460 and VH 820 humidifiers.

Battery Cables
Designed and labeled to ensure proper polarity connection.

One Way Valve
An optional, one-way valve which is placed on the exhalation port of the patient manifold (with or without PEEP assembly) for two purposes:

a. To ensure that all patient inhalations come from the ventilator when the optional FIO_2 accumulator is being used.
b. To increase the sensitivity of the assist detector when ASSIST SENSITIVITY is being used.

PEEP Valve
An optional mechanical device which mounts on the exhalation port of the patient manifold.

Humidifier Mount
An optional bracket to mount the humidifier on the right side of the BEAR® 33 Ventilator.

Oxygen Accumulator
A device which connects to the ventilator inlet port. This device allows delivery of oxygen enriched air to the patient. By metering the oxygen supply and monitoring the delivered gas, FIO_2 levels of 21 to 90% may be administered to the patient.

Table 1-6
Specifications

Parameter	Range	Accuracy
Tidal Volume	100 to 2200 cc	5% of setting or 20 cc, whichever is greater
Rate	2 to 40 BPM	5% of setting or 1 BPM, whichever is greater
Sigh Volume	150 to 3000 cc	5% of setting or 30cc, whichever is greater
Peak Flow	20 to 120 LPM	10% of setting
Assist Sensitivity	-9cmH_2O to 19 cmH_2O	2.0 cmH_2O
High Pressure Alarm and Relief	0 to 80 cmH_2O	0.0 to 65 cmH_2O ±2 cmH_2O 65 to 80 cmH_2O ±3 cmH_2O
Low Pressure	3 to 70 cmH_2O	3.0 to 65 cmH_2O ±2 cmH_2O 65 to 70 cmH_2O ±3 cmH_2O
Apnea Period	20 seconds	1.0 second
Alarm Silence	60 seconds	1.0 second
Proximal Airway Pressure Gauge	-10 to 100 cmH_2O	3 cmH_2O from -10 to +25 cmH_2O 1 cmH_2O from 25 to 75 cmH_2O 3 cmH_2O from 75 to 100 cmH_2O
Overpressure Relief Valve	85 to 125 cmH_2O	6 cmH_2O
Alarm Loudness	85 dB at 10cm	5dB
Tidal Volume with PEEP	100 to 2200 cc	±10% of setting

SECTION 2
BEAR® 33 VOLUME VENTILATOR THEORY OF OPERATION

Electronic System

The BEAR® 33 electronics consists of five modules, each on a printed circuit board. The function of each module and the interactions between them will be discussed first, followed by a detailed discussion of the functions of each of the modules. The modules and the interface connections between them are illustrated in Figures 2-1 and 2-1A (pages 2-2 and 2-3).

Interaction Between Modules

The two main modules are the monitor and the controller. The monitor connects to the front panel keys, display module and the controller. The function of the monitor is to interface with the user through the keyboard and displays and to monitor the performance of the controller to verify its operation. The monitor communicates current user settings to the controller through a serial communications channel, and monitors several status lines from the controller.

The controller module connects to the motor drive module, which drives the motor and controls various solenoids and other devices in the ventilator. It also communicates with the monitor and sends status signals to the monitor.

The controller interfaces with the sensor module , receiving input from the encoder and home sensor. Power routing and voltage regulation occurs in the controller.

Monitor Interface

The monitor interfaces with keys through 15 lines to the front panel and through the controller to the unlock key. One line to the front panel is +5 volts and is common to one side of all the keys. The other sides of the SPST key switches return to the monitor. The unlock key interfaces through the controller board.

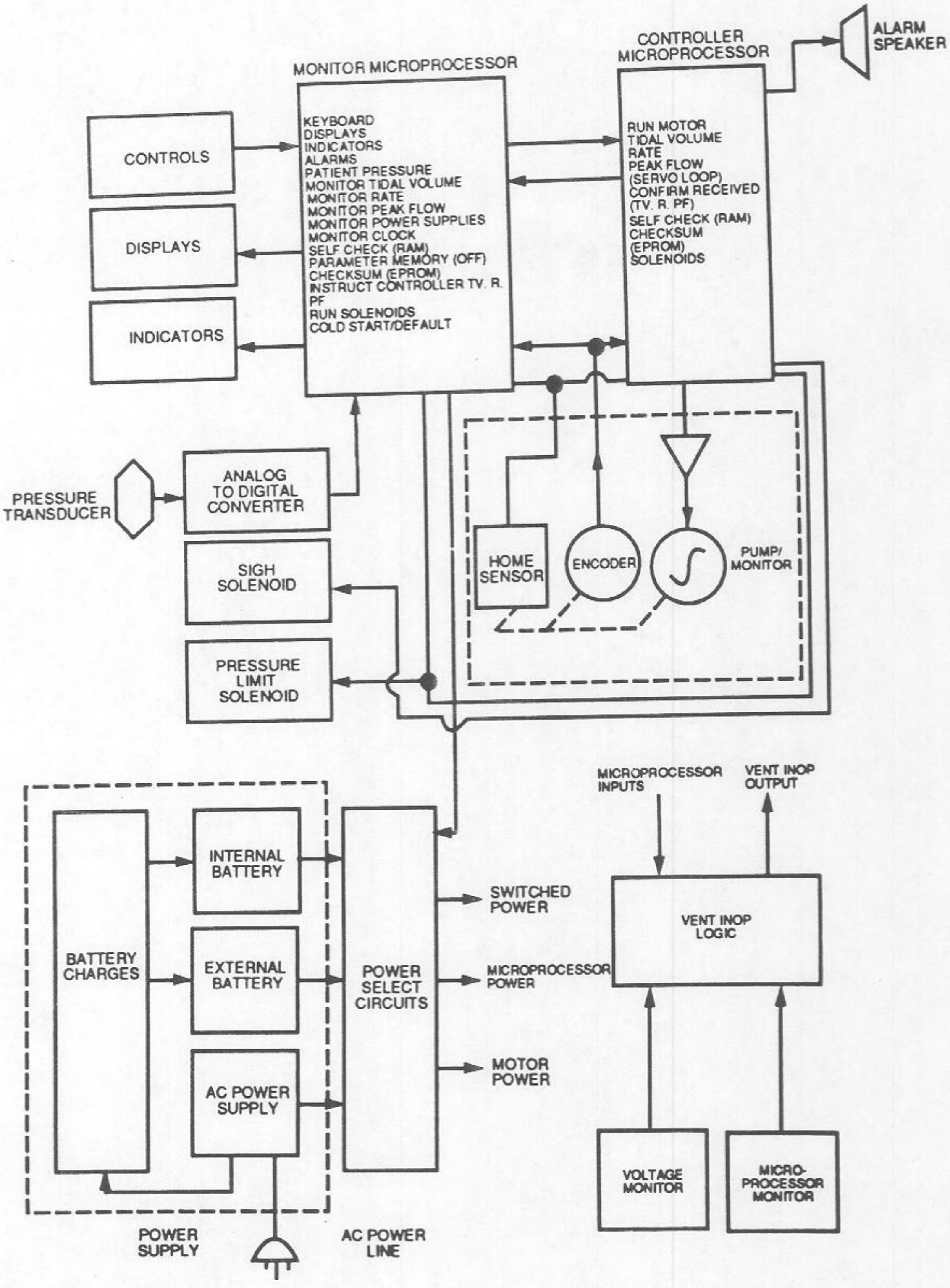
The monitor interfaces with the display board through 150 lines. There is one line for each display segment. Some groups of segments are always on or off together and are controlled by one line. There are also three backplace lines, one line for each front panel LED, and two power lines for the LEDs. The display segment signals and backplane signals are square waves and the phase of a segment signal with respect to its backplane signal determines whether the segment is on or off. In-phase is off, 180 degrees out-of-phase is on. The LED lines are pulled to ground and to turn an LED on. All LEDs are powered from +10 volts except the VENT INOP LED, which is powered from a power supply line which carries the higher of the two battery voltages.

The monitor interfaces with the controller through 26 lines on P5. Table 2-1 (page 2-4) defines the 26 lines.

The Central Processor

The central processor (CPU) block contains the CPU (U10), low order address latch (U14), the program memory (U13), the address decoder (U7), and peripheral interface devices (U11 and U12). Sixteen CPU input/output (I/O) lines connect the CPU to the front panel keys.

Software programs these I/O lines as inputs, scans them for key closures, and debounces the keyswitch closures. One of the I/O lines receives the SIGH signal from the controller. The address decoder provides address strobes to the peripheral interface devices, to the analog-to-digital (A/D) converter, and to the LCD drivers when the processor writes or reads a particular address. Peripheral interface U11 (Figure 2-1A) has some I/O pins programmed as outputs to drive the front panel LED drivers, some LCD segments, and the RELIEF and EFFORT signal to the controller. Other I/O lines are programmed as inputs to receive data from the keyboard encoder. Peripheral interface U12 (Figure 2-1A) has I/O pins programmed by the software to provide several input/output signals to the controller, four bits of BCD data to the LCD.

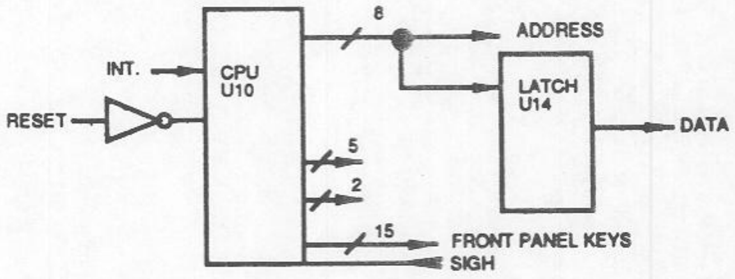


ALARM SPEAKER
CONTROLLER MICROPROCESSOR
MONITOR MICROPROCESSOR
CONTROLS
DISPLAYS
INDICATORS
KEYBOARD
DISPLAYS
INDICATORS
ALARMS
PATIENT PRESSURE
MONITOR TIDAL VOLUME
MONITOR RATE
MONITOR PEAK FLOW
MONITOR POWER SUPPLIES
MONITOR CLOCK
SELF CHECK (RAM)
PARAMETER MEMORY (OFF)
CHECKSUM (EPROM)
INSTRUCT CONTROLLER TV. R. PF
RUN SOLENOIDS
COLD START/DEFAULT
RUN MOTOR
TIDAL VOLUME
RATE
PEAK FLOW (SERVO LOOP)
CONFIRM RECEIVED (TV. R. PF)
SELF CHECK (RAM)
CHECKSUM (EPROM)
SOLENOIDS
PRESSURE TRANSDUCER
ANALOG TO DIGITAL CONVERTER
SIGH SOLENOID
PRESSURE LIMIT SOLENOID
HOME SENSOR
ENCODER
PUMP/ MONITOR
BATTERY CHARGES
INTERNAL BATTERY
EXTERNAL BATTERY
AC POWER SUPPLY
POWER SELECT CIRCUITS
SWITCHED POWER
MICROPROCESSOR POWER
MOTOR POWER
MICROPROCESSOR INPUTS
VENT INOP OUTPUT
VENT INOP LOGIC
VOLTAGE MONITOR
MICRO-PROCESSOR MONITOR
POWER SUPPLY
AC POWER LINE

Figure 2-1 • ELECTRONIC BLOCK DIAGRAM

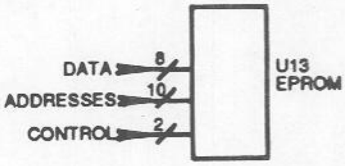
21

b. Central Processing Unit



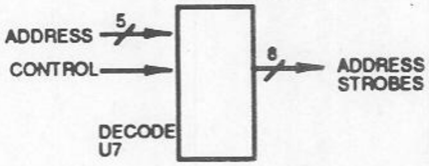
8
ADDRESS
INT.
CPU
U10
LATCH
U14
RESET
DATA
5
2
15
FRONT PANEL KEYS
SIGH

c. EPROM



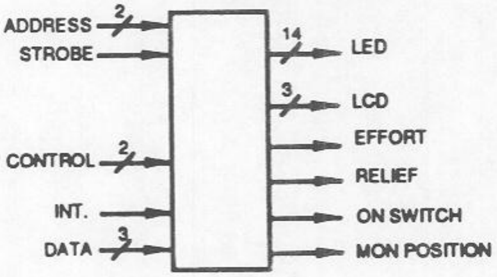
DATA
8
ADDRESSES
10
CONTROL
2
U13
EPROM

d. Address Decoder

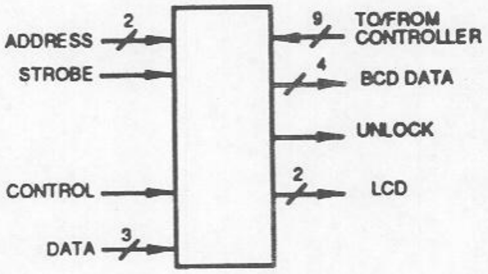


ADDRESS
5
CONTROL
8
ADDRESS
STROBES
DECODE
U7

e. Peripheral Interface



ADDRESS
2
STROBE
14
LED
3
LCD
EFFORT
CONTROL
2
RELIEF
INT.
ON SWITCH
DATA
3
MON POSITION



2
ADDRESS
9
TO/FROM
CONTROLLER
STROBE
4
BCD DATA
UNLOCK
CONTROL
2
LCD
DATA
3

Figure 2-1A • ELECTRONIC BLOCK DIAGRAM, CONTINUED

Table 2-1

Line	Function
5 volts	Regulated voltage present even if the ventilator is off
5 volts switched	Regulated voltage switched off if the ventilator is off
10 volts	Regulated, switched off if ventilator is off
BUS SWITCHED	Unregulated, switched off with power
EXT BATT VOLTAGE	Connected to external battery
INT BATT VOLTAGES	Connected to internal battery

The above voltages provide power to the monitor and display boards; allow monitoring of voltages for power switching and tolerance checking of regulated voltages

Line	Function
$\overline{\text{HOME}}$	Indicates that piston is at the end of the inspiratory stroke (negative logic)
MON POSN	A pulse waveform which pulses for each incremental movement of the piston
SIGH	Indicates a sigh breath is in progress
INSP	Indicates the inspiratory portion of a breath is in progress
RCV DATA	Serial data from the controller

The above signals are sent from the controller to monitor

Line	Function
SND DATA	Serial data sent from the monitor to controller
DATA CK	A square wave generated by the monitor to synchronize serial data transfers
EFFORT	Indicates that proximal pressure is below level set on the assist sensitivity display.
$\overline{\text{RESET}}$	Goes low whenever ventilator is turned off
BUS ON	Turns on switchable voltages (see above) when high
RFLIEF	Deenergizes relief solenoid when high, allowing exhalation balloon to dump patient pressure
INT ON	When high, connects internal battery as a power source
INOP1	When set high, causes ventilator to go INOP

The above signals are generated by the monitor microprocessor

Line	Function
CK FAIL	When high, causes a VENT INOP; indicates a monitor microprocessor failure
UNLOCK	From the UNLOCK key
ASST BR	Goes high to blink the assist LED; from the controller microprocessor
CHARGING	Goes high when the bus voltage is high enough to charge the batteries; from the controller
INOP LED	Goes high if VENT INOP or in test mode; from controller logic

The Reset/Clock Fail System

The monostable multivibrator in Figure 2-2 is regularly strobed by the DATA CKL signal when the processor (CPU) is running. If the DATA CLK signal is not received by the monostable, it generates a reset pulse to the CPU. If the reset pulse does not restore normal operation, the monostable times out, and a CLOCK FAIL signal is generated causing a VENT INOP alarm condition. A NOR gate (Figure 2-2) uses one input from the monostable and one from the ON signal to inhibit the reset signal when the power is turned off.

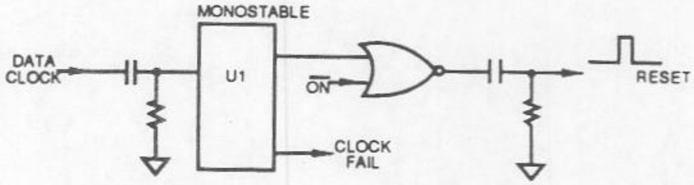


Figure 2-2
RESET/CLOCK FAIL SYSTEM

Power ON/OFF Circuit

A D-type flip flop (U8 in Figure 2-3) is clocked each time the ON button is pressed. This on-signal input is also fed to the central processor generating an interrupt to the CPU. The interrupt causes the CPU to come out of its low power "stop" condition and start running. The outputs of the D flip flop go to the ON-LED driver, the BUS ON signal (which turns power on at the controller board), and the $\overline{\text{RESET}}$ signal to the controller board. The controller board $\overline{\text{RESET}}$ signal generates a "good" power-on reset to the controller CPU.

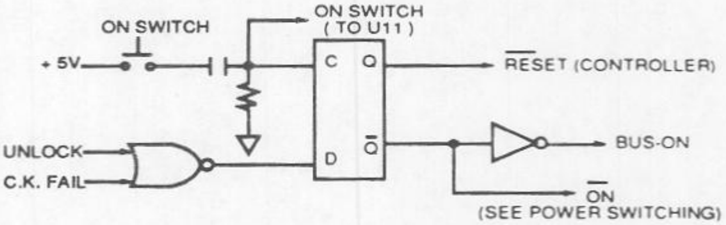


Figure 2-3
POWER ON/OFF CIRCUIT

The Q output of the flip flop assumes the logic state of the D input as soon as it is clocked. If UNLOCK or CLOCK-FAIL is true, the D input is low, and $\overline{\text{RESET}}$

and BUS-ON go low when ON is pressed. This happens if the UNLOCK button has been pressed, and the monitor processor has turned on the UNLOCK LED, or if there has been a clock fail condition. When BUS ON goes low, all power except 5 volts (not 5 volts switched) goes off. Since the monitor processor is powered by 5 volts, it remains on. It senses the ON SWITCH signal, however, and goes into a low power sleep mode if it was unlocked when the signal was detected. This allows the processor memory (RAM) to retain the set front panel data. The processor also clears all of the displays before going to sleep.

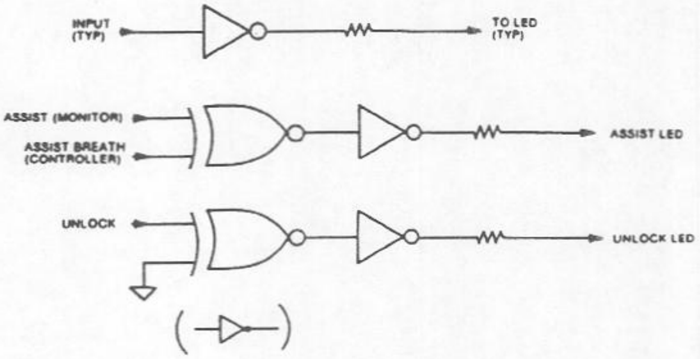

INPUT (TYP)
TO LED (TYP)
ASSIST (MONITOR)
ASSIST BREATH (CONTROLLER)
ASSIST LED
UNLOCK
UNLOCK LED

Figure 2-4
LED DRIVERS

When the power goes off, the CLOCK FAIL signal goes low, and the monitor processor sets UNLOCK low, the D input to the flip flop goes high, and on the next press of the ON button, the processor wakes up and power goes on.

LED Drivers

The LED drivers are open collector transistor drivers with series resistors to limit the LED current. The ASSIST driver is arranged so the controller can blink this LED if it is on (in ASSIST CONTROL) or off (in SIMV).

LCD Display Drivers

There are four LCD display drivers as shown in Figure 2-5. They receive BCD data from the central processing unit, addresses from the CPU, and a strobe from the address decoder. One of four digits for each driver IC may be addressed. The BCD data are latched in the driver. The driver ICs generate the segment data and a backplane signal. The backplane signals for U19 and U20 are connected together. The backplane and segment signals are square waves, and the phase of the segment signal with respect to the backplane signal determines whether the segment will be on or off (180 degrees out-of-phase is on; in-phase is off). U15 and U16 (Figure 2-5) drive additional segments

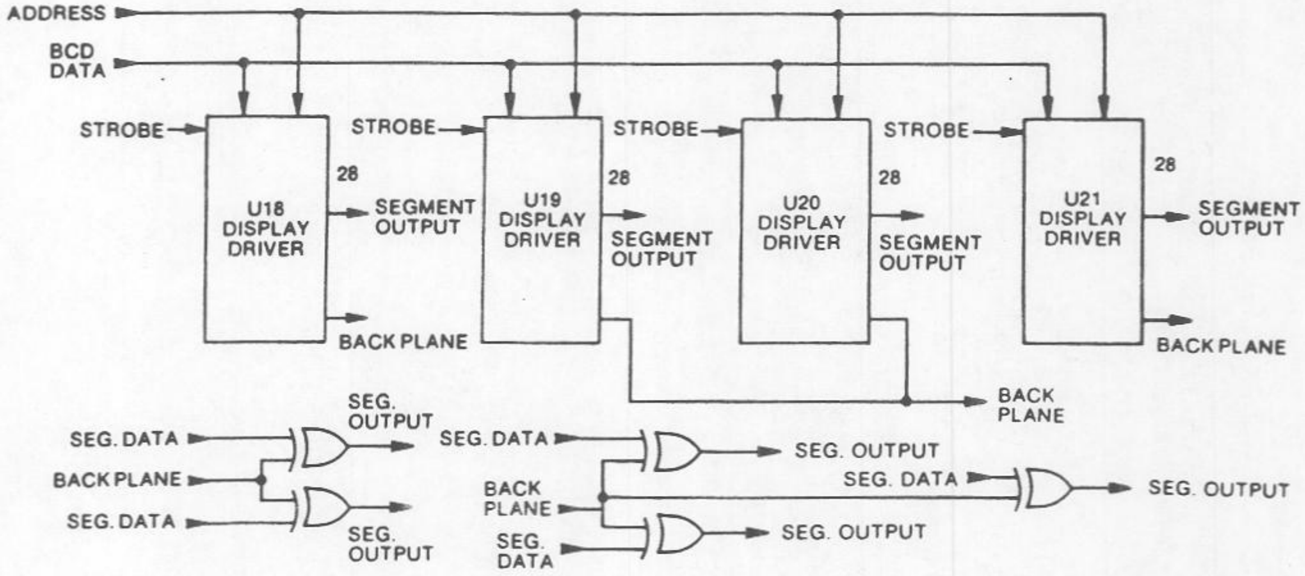

ADDRESS
BCD DATA
STROBE
U18 DISPLAY DRIVER
28
SEGMENT OUTPUT
BACK PLANE
STROBE
U19 DISPLAY DRIVER
28
SEGMENT OUTPUT
STROBE
U20 DISPLAY DRIVER
28
SEGMENT OUTPUT
BACK PLANE
STROBE
U21 DISPLAY DRIVER
28
SEGMENT OUTPUT
BACK PLANE
SEG. DATA
BACK PLANE
SEG. DATA
SEG. OUTPUT
SEG. OUTPUT
SEG. DATA
BACK PLANE
SEG. DATA
SEG. OUTPUT
SEG. OUTPUT
SEG. DATA
SEG. OUTPUT

Figure 2-5
LIQUID-CRYSTAL DISPLAY (LCD) DRIVER SYSTEM

by combining an input signal (DISP ON, PK FLOW1, RATE DP, ASST ON, and EFFORT) with the appropriate backplane signal to produce the proper phase square wave to the LCD segment.

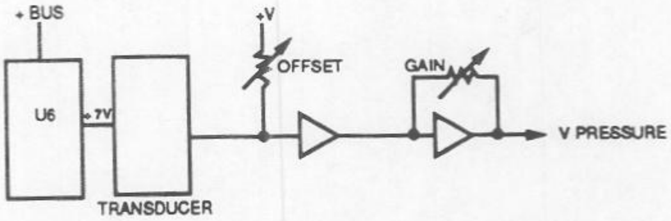
Pressure Transducer System

The pressure transducer outputs a voltage proportional to input pressure, but also has a constant offset voltage. The first Op Amp removes most of the offset, but retains a small positive offset to allow a slight negative pressure to be sensed without requiring a negative supply voltage. The signal is scaled by the second Op Amp to about 39 millivolts per cmH_2O. The operational amplifier is offset by about 780 millivolts to allow the transducer to provide pressure data down to -20 cmH_2O. The offset error is compensated for in the processor software.

An on-board regulator supplies the regulated +7 volts required by the pressure transducer.

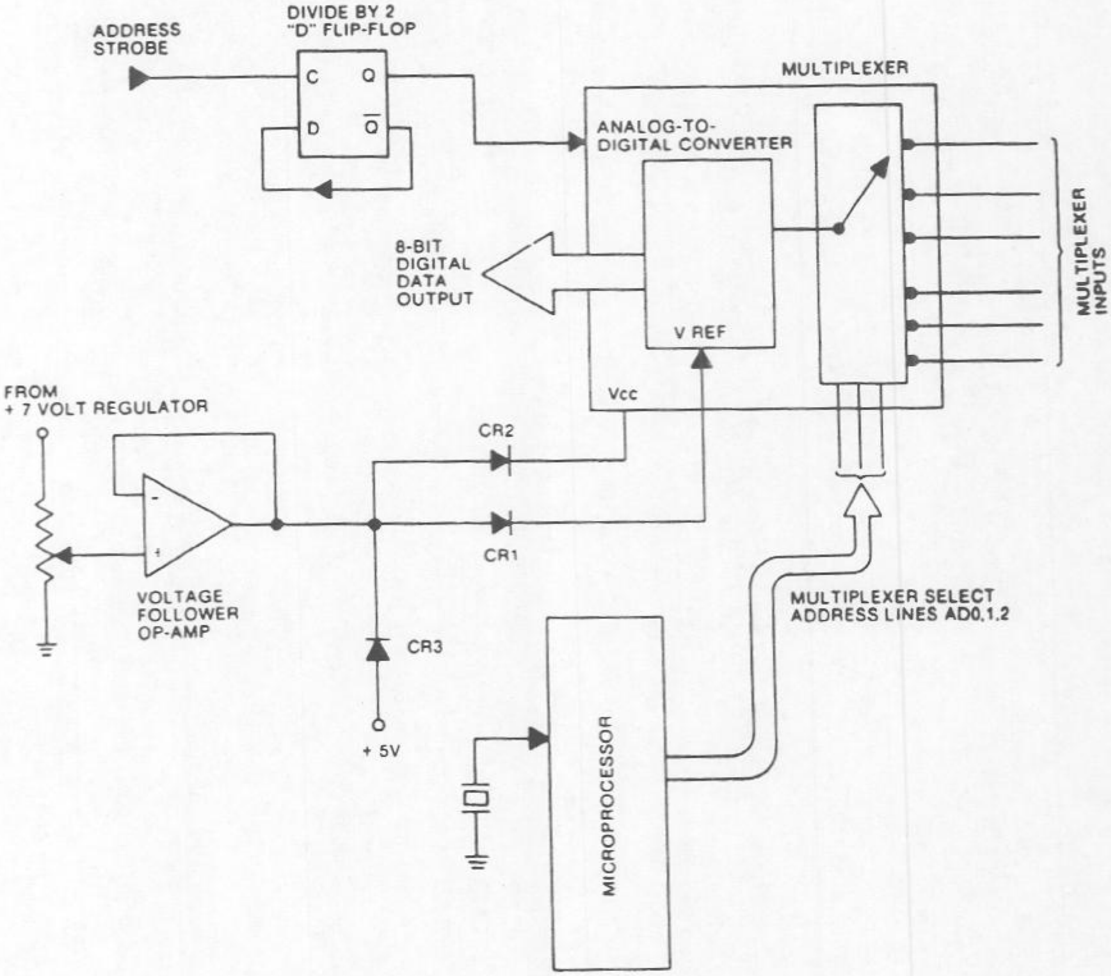
Analog -to-Digital (A/D) Converter

The voltage follower in Figure 2-7 provides a reference voltage and power for the A/D converter. The voltage



+ BUS
+V
OFFSET
GAIN
U6
+7V
TRANSDUCER
V PRESSURE

Figure 2-6
PRESSURE TRANSDUCER SYSTEM



ADDRESS STROBE
DIVIDE BY 2 "D" FLIP-FLOP
C
Q
D
$\overline{Q}$
MULTIPLEXER
ANALOG-TO-DIGITAL CONVERTER
8-BIT DIGITAL DATA OUTPUT
V REF
MULTIPLEXER INPUTS
Vcc
FROM + 7 VOLT REGULATOR
CR2
CR1
VOLTAGE FOLLOWER OP-AMP
CR3
+ 5V
MULTIPLEXER SELECT ADDRESS LINES AD0,1,2
MICROPROCESSOR

Figure 2-7
ANALOG-TO-DIGITAL CONVERTER

follower derives its input from the 7 volt reference voltage output of a 723 voltage regulator and provides adequate current to run the A/D converter. These voltages are diode gated to ensure the converter retains power when AC power is off. The A/D's clock is derived by using a "D" flip flop to divide the frequency of the processor address strobe signal by two. The A/D has eight multiplexed inputs, six of which are used. The converter measures proximal pressure (from the transducer), internal battery voltage, external battery voltage, bus voltage, 5 volts switched, and 7 volts (transducer supply voltage). The battery and bus voltages are used to select the power source, and the other voltages are tested to verify they are within the tolerance range. An out-of-tolerance voltage results in a VENT INOP condition. The voltages are divided down to within the A/D's full scale range and filtered to eliminate noise. The processor starts conversions, selects the channel to be converted, and reads the converted data by reading or writing to the appropriate decoded address. The A/D has three low order multiplexer address inputs for selecting the channel to be converted.

THE CONTROLLER SYSTEM

A detailed description of the controller system follows.

Central Processor

The processor consists of the CPU (U15), low order address latch (U26), program memory (U25), address decoder (U17), and output latch (U27). The CPU contains sixteen I/O pins which are programmable to software. These are used for the interface to the monitor.

The CPU I/O communicates the following data:

1. Senses the air-pump motor direction (DIR).
2. Senses when the pump piston is in the "Home" position ($\overline{\text{HOME}}$).
3. Provides sigh solenoid operation commands (SIGH SOL).
4. Provides VENT INOP (INOP2) signal.
5. Provides relief valve control signals
6. Provides directional control (forward and reverse) signals to the motor driver module (MOTOR FWD and MOTOR REV).
7. Controls the hour meter.
8. Senses the bus voltage (GAIN SW).

The output latch (U27) latches data used to control motor speed. U17, the address decoder, strobes the latch when data is written to its address.

The processor is interrupted by an input coming from the encoder, and counts the number of these inputs to track the air pump piston position. The processor uses the DIR signal to determine if the count should be increased or decreased, depending on motor direction. In this way, the absolute position of the piston is always known. When power is first turned on, the $\overline{\text{HOME}}$ signal goes low, indicating home position. The processor then initializes the position counter (in RAM). In operation, the home position is constantly checked, and the position count is checked when the piston is in the home position. In this way, any small drift from the correct position can be corrected, and a major problem can be detected.

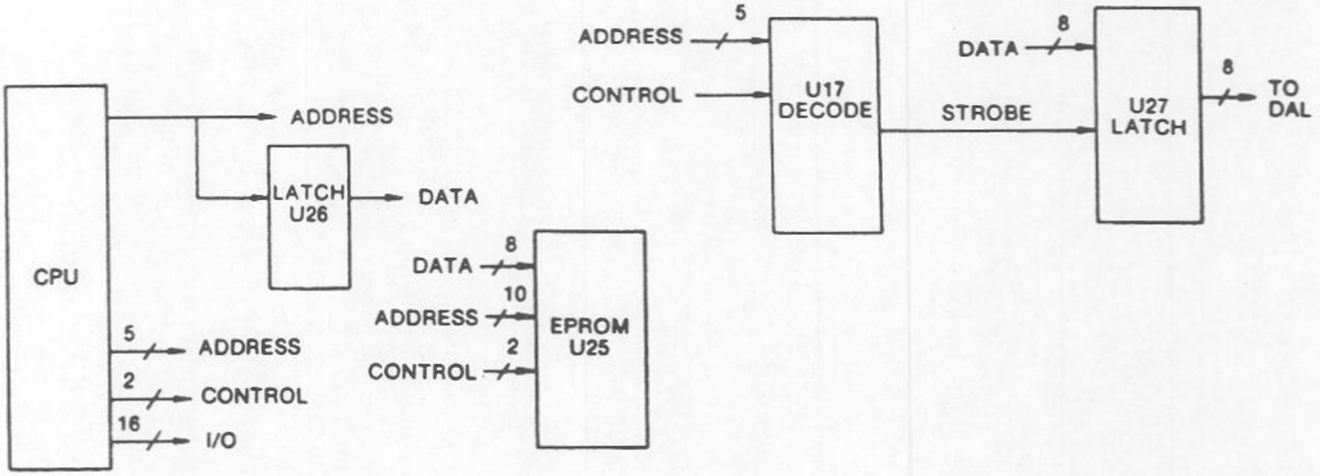


Figure 2-8
CENTRAL PROCESSOR

Position/Direction Logic

The optical encoder on the piston drive motor shaft provides two outputs, which are square waves in quadrature (90 degrees out-of-phase). U10 buffers these signals and the "D" flip flop (U19) outputs a direction signal, determined by which of the two encoder signals leads in phase. The position pulse is derived from two signals, and divided by four by counter U16, and fed to the processor interrupt input.

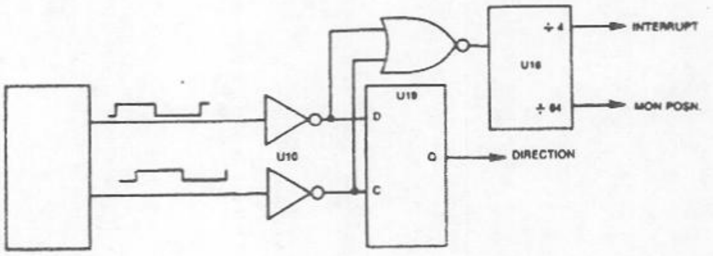


Figure 2-9
POSITION/DIRECTION LOGIC

Motor Drive

Data on the data bus from the CPU is latched in an 8-bit latch. The output voltages from the latch (U27) is shifted from 5 volts to 10 volts by U21/U28 to drive the D/A converter. The converter is connected in an unusual configuration to use only a positive supply. The output of the D/A converter is buffered and level-shifted by U30/U31 to a suitable level for the pulse-width modulator (U23). A pulse-width modulating circuit converts an input voltage. The MOTOR FWD and MOTOR REV signals and pulse output go to the motor driver PCB. The frequency of the pulse width modulator is about 26 KHz, so there is little audible noise from the motor. R21 (R53 on newer units) senses motor current and causes the pulse width modulator to reduce its duty cycle if motor current is excessive. This current limit condition is high enough that any possible pressure and peak flow will not cause current limit. The pulse width modulator has a shut-down input which reduces the output duty cycle to zero if it goes high. This input is driven by the VENT INOP logic to cause the motor to stop if a VENT INOP occurs.

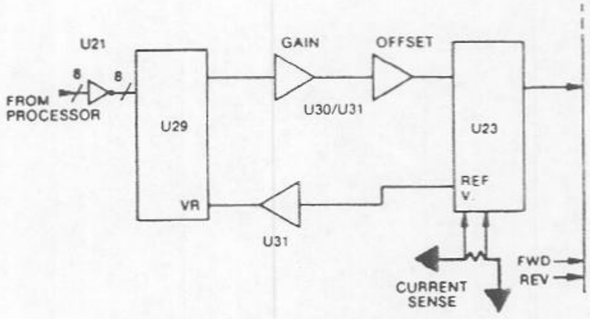


Figure 2-10
MOTOR DRIVE SYSTEM

Servo Loop

The motor is operated in a servo loop consisting of both hardware and software. The software finds a desired position for the piston through a lookup table and makes calculations to account for the set operating parameters. The piston position is constantly updated. The actual position value is compared to the required position value and the difference between them is found. The difference is multiplied by a gain value, and sent to the D/A converter to driver the motor. The larger the error, the harder the motor is driven. The gain factor is changed if the bus voltage is low in order to compensate for the lower drive voltage available to the motor.

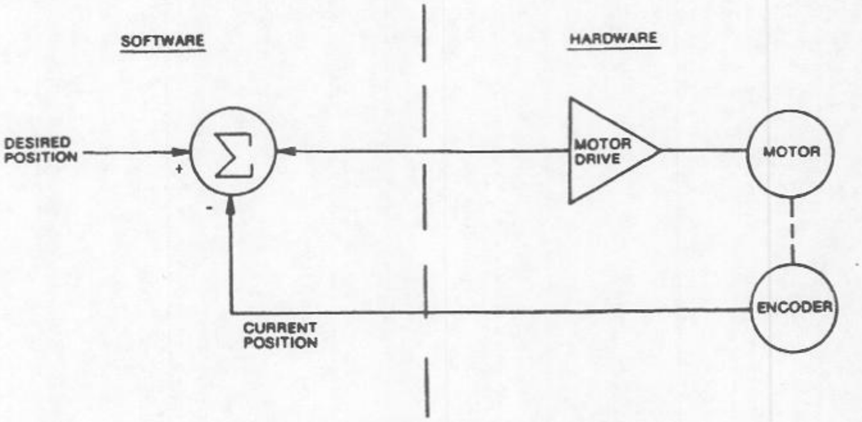


Figure 2-11
SERVO LOOP

Power Switching

The internal and external batteries feed the main bus through CR1. CR1 is a Schottky diode which provides a low forward bias voltage drop. The relay K1 is held open when the internal battery is not in use to prevent the internal battery from providing power if the external battery is low. The power switching decision is made by the monitor processor which drives the relay driver with the INT ON signal. If the internal battery is chosen, whichever battery has the higher voltage will provide the power. Two diodes are used to provide an OR function. If the voltage from the power transformer is adequate, it becomes the power source. CR4 also acts as an OR type switch. When the monitor senses that the bus voltage is higher than the batteries can provide, it disconnects the internal battery (if connected) and switches to WALL AC. The switched but connects to the emitter of Q3 which is turned on when the BUS ON signal goes high.

If the external battery or AC is disconnected causing a switch to internal battery, there will be a momentary loss of power while the relay switches. CR25-CR28 provide power from the internal battery during the relay switching time to ensure that the voltage regulators do not drop out. The +5 volt regulator (U6) is always powered, and provides 5 volts to the monitor. The 5 volt regulator (U2) provides 5 volts which is switched off when the power is turned off. The 10 volt regulator powers the displays and motor driver, which is switched off if the ventilator is off. Zener diode CR13 allows the CHARGING indicator to light when the supply voltage is high enough to to allow the battery chargers to operate. Zener diode CR29 allows the controller processor to sense when the supply voltage is low, so it may increase the gain in the servo loop at low voltages to compensate for the loss of gain in the motor driver.

A transistor (Q8) disconnects the battery meter to prevent it from draining the battery when the ventilator is not in use.

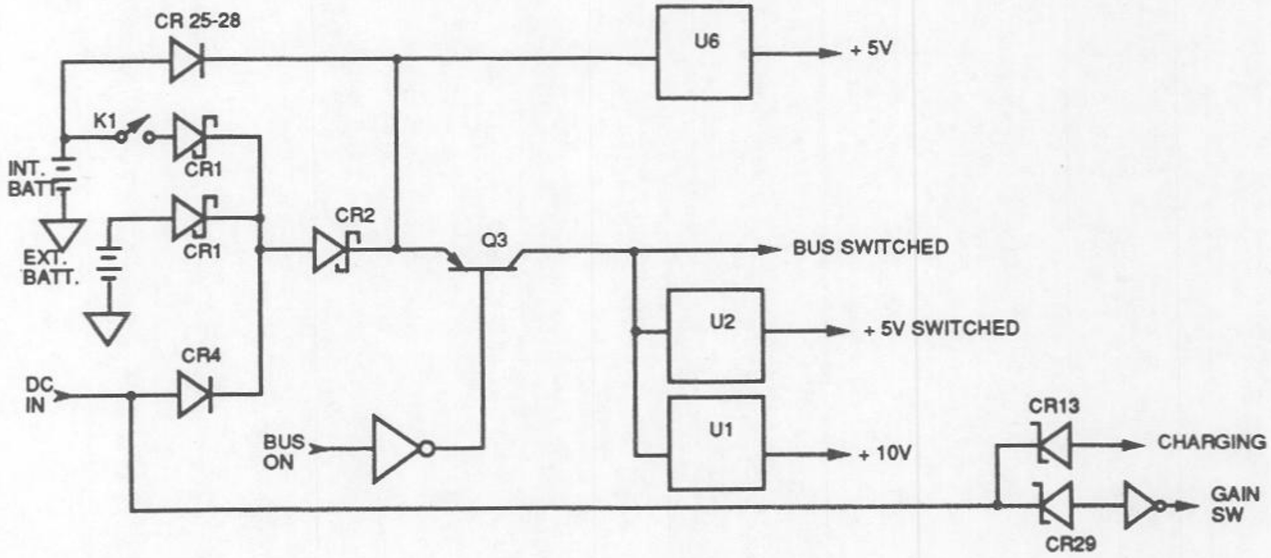


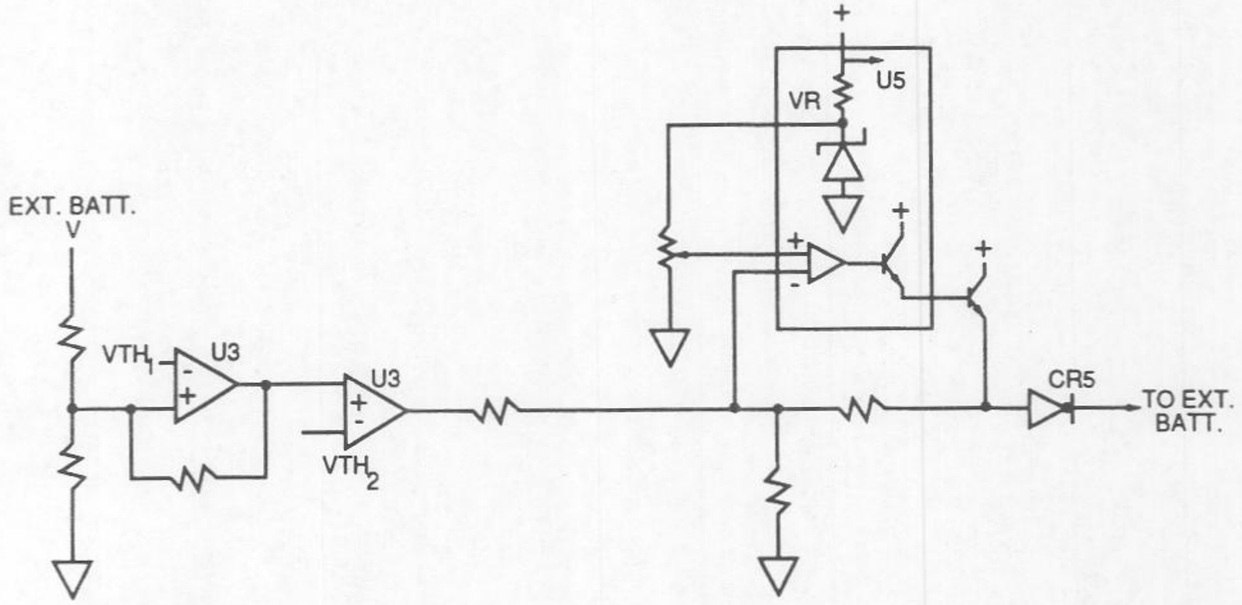
Figure 2-12
POWER SWITCHING CIRCUIT

External Battery Charger Circuit

A dual comparator (U3) causes a voltage regulator (U5) to switch to one of two levels. When the battery is very low, the charger voltage is raised to increase the charging current. When the battery voltages rise to near its upper limit, the charger voltage drops to prevent excessive battery charging current and possible battery damage.

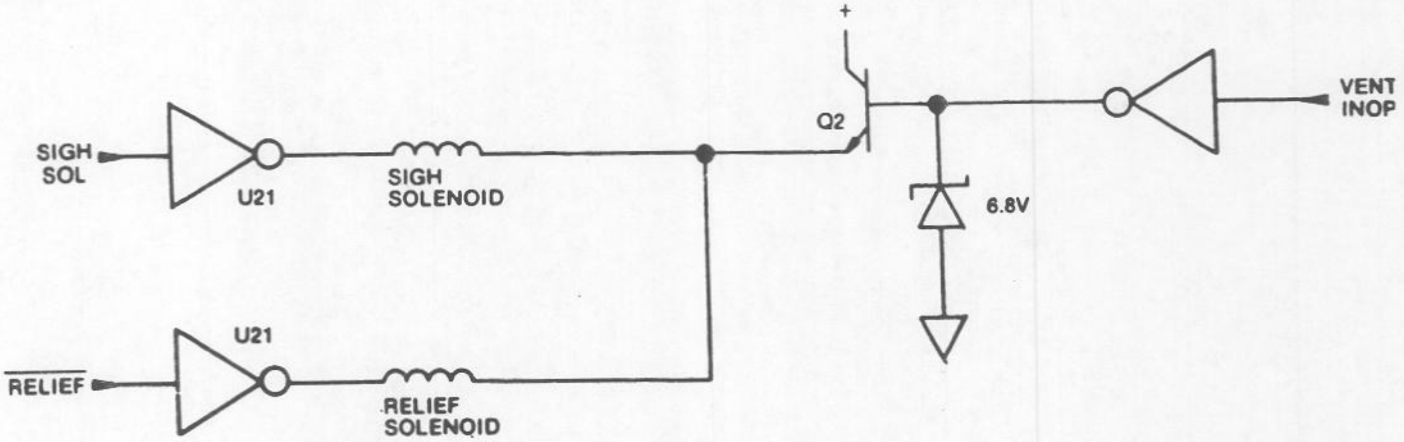
Solenoid Drivers

One of the seven Darlington transistors in a ULN 2003 IC drives the sigh solenoid on when the controller sets the signal SIGH SOL high during the second stroke of a sigh breath. The relief solenoid is driven by another section of the ULN 2003. The relief solenoid is turned off by the controller during initialization and recovery from a high pressure relief, and the monitor drives it off during a high pressure relief. Normally, the solenoid is on. The power to these solenoids is removed during a VENT INOP condition.



EXT. BATT.
V
VTH1
U3
U3
VTH2
VR
U5
CR5
TO EXT. BATT.

Figure 2-13
BATTERY CHARGING CIRCUIT



SIGH SOL
U21
SIGH SOLENOID
RELIEF
U21
RELIEF SOLENOID
Q2
6.8V
VENT INOP

Figure 2-14
SOLENOID DRIVERS

INOP Logic

The following conditions will generate a VENT INOP signal:

1. Either of the two 5-volt power supplies is out of tolerance.
2. The motor will not respond correctly to commands from the controller processor – or the controller power-up test of the ROM produces a faulty checksum (INOP2).
3. The monitor microprocessor fails to operate (CK FAIL).
4. Any of the monitor INOP conditions listed on Page 1-5 occurs (INOP1).

Audible Alarm

The audible alarm consists of a narrow pulse modulated by a lower frequency square wave. A 2N5783 transistor drivers the speaker, which resonates near the narrow pulsed frequency to provide relatively loud sound with low power consumption. The "supercap", C14, provides enough power to operate the alarm circuit for over one minute if all power should fail (this causes the alarm circuit to turn on). C14 is charged from 5 volts SWITCHED in normal operation. Any audible alarm also provides the proper drive for the remote alarm if it is connected.

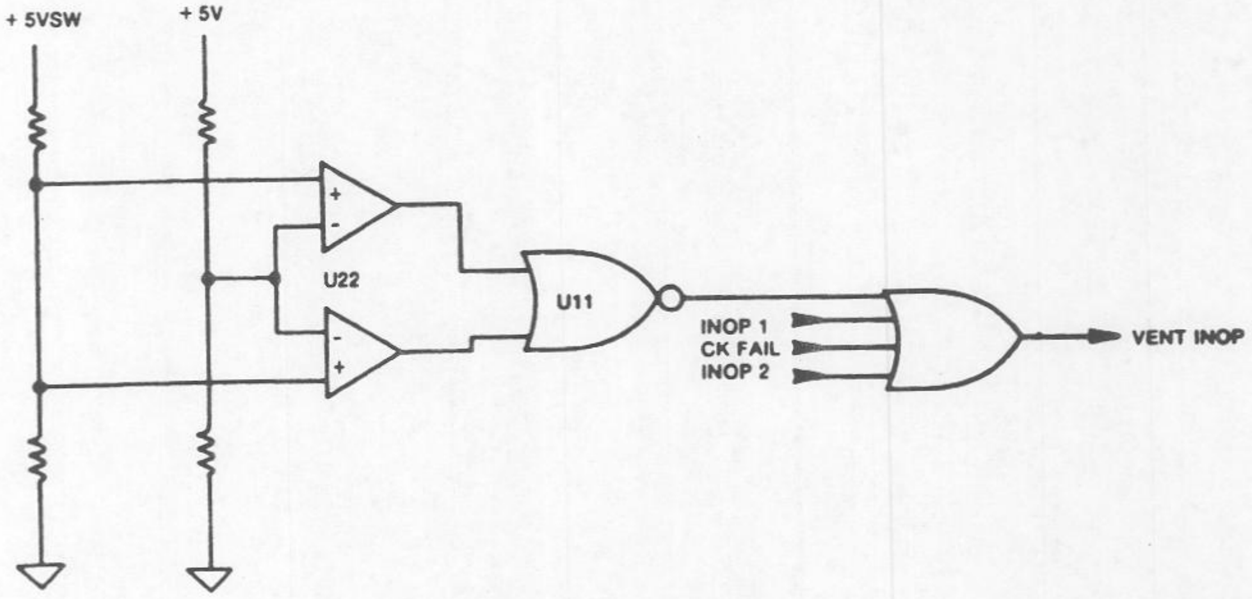


Figure 2-15
VENT INOP LOGIC

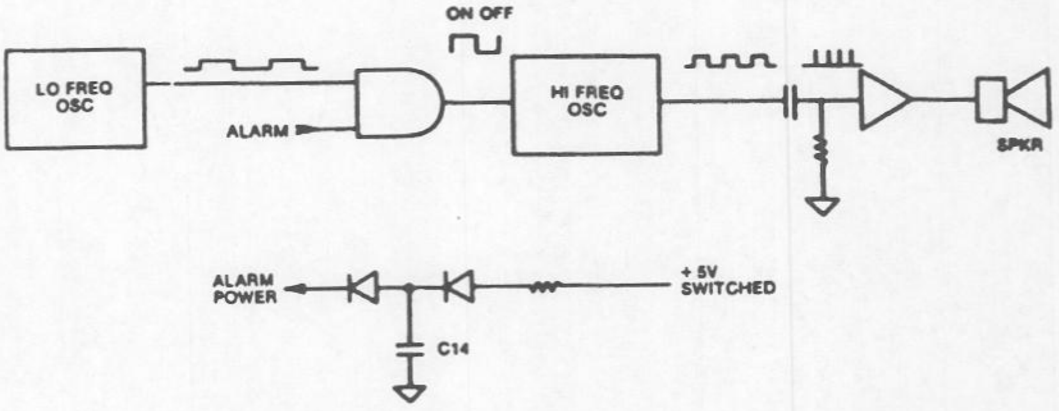


Figure 2-16
AUDIBLE ALARM

Motor Driver Module

The motor driver receives inputs for direction and speed (pulse width modulated) from the controller and motor position inputs from the motor. These are input to the PROM U1, which provides the correct outputs to the three motor winding drivers.

The position inputs from the motor, combined with the direction inputs, determine the sequence in which the motor windings are switched. The pulse width modulated input causes the active windings to be switched on and off at the duty cycle of the PWM signal, which varies motor speed.

The motor winding drivers can both source and sink current to the motor windings, which are connected in a "wye" configuration, as indicated.

Display Module

The display PCB contains no active circuitry. It hold the LCD numerical displays and the LEDs, which are backlit from the front panel legends. The LEDs are powered from the 10-volt source, except for the VENT INOP LED, which is powered from either the internal or external battery, whichever has higher voltage. The LCDs are all driven by the monitor board.

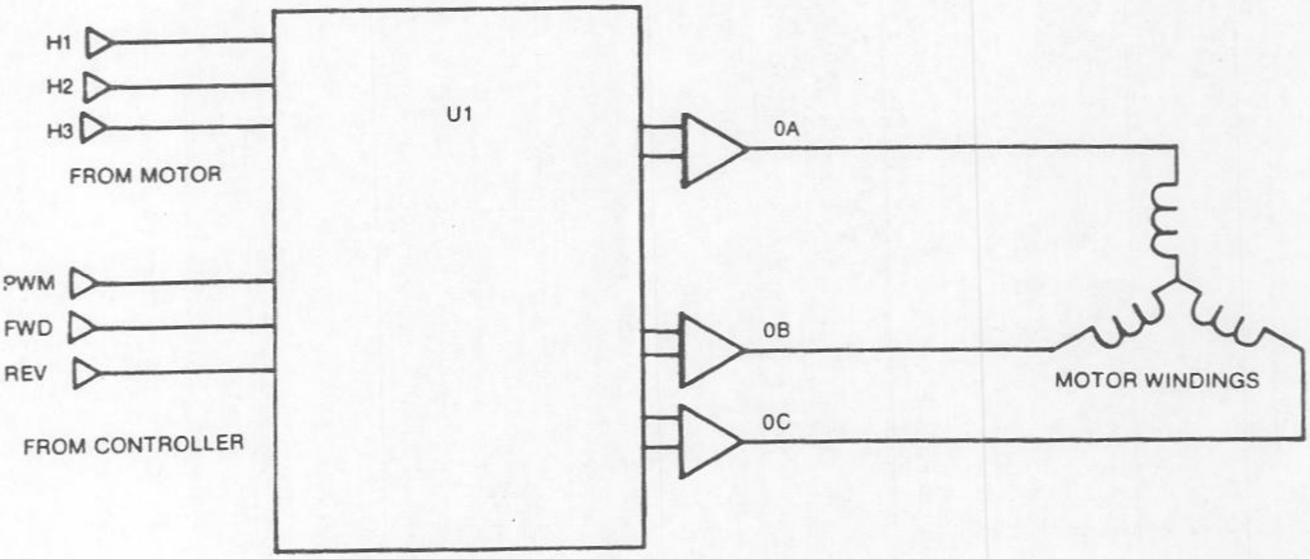


Figure 2-17
DRIVERS Q1-Q6

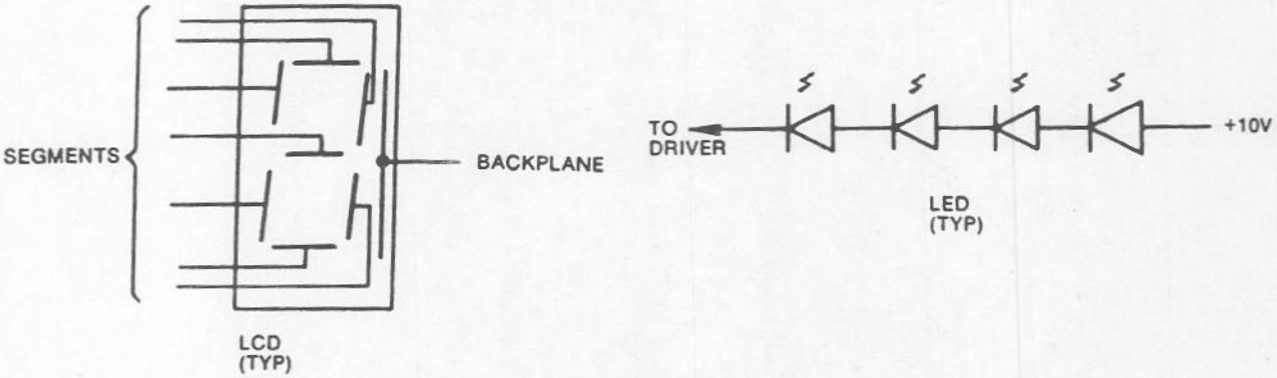


Figure 2-18
DISPLAY MODULE

31

Sensor Module

The sensor PCB contains the internal battery charger circuit, the home sensor, and carries wiring to the encoder.

The internal battery charger is a current limited voltage regulator which charges the battery at a relatively high voltage until it is nearly charged, and then drops to a lower "float" voltage which can be safely maintained across the battery indefinitely. The internal battery voltage is routed to the controller board through this board. The home sensor is an optically coupled slot which consists of an LED and a photo transistor. When the flag on the piston assembly enters the sensor slot, the transistor turns off, sending a "$\overline{\text{HOME}}$" signal to the controller.

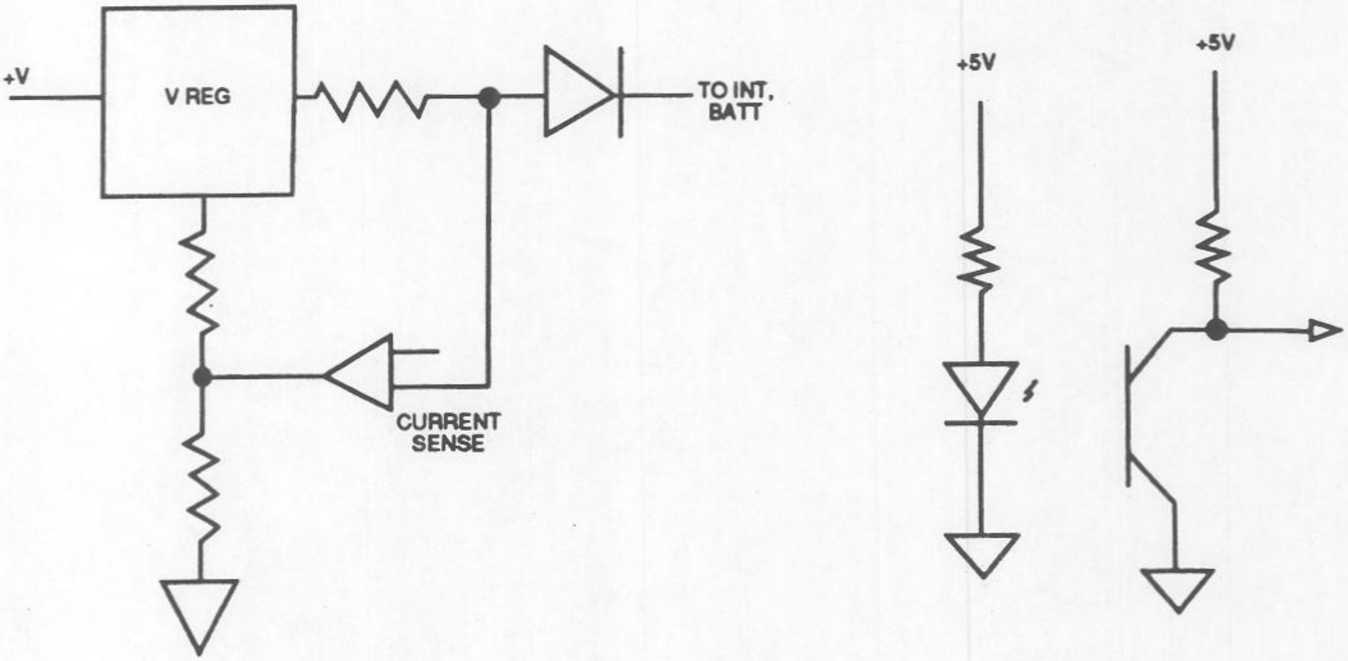
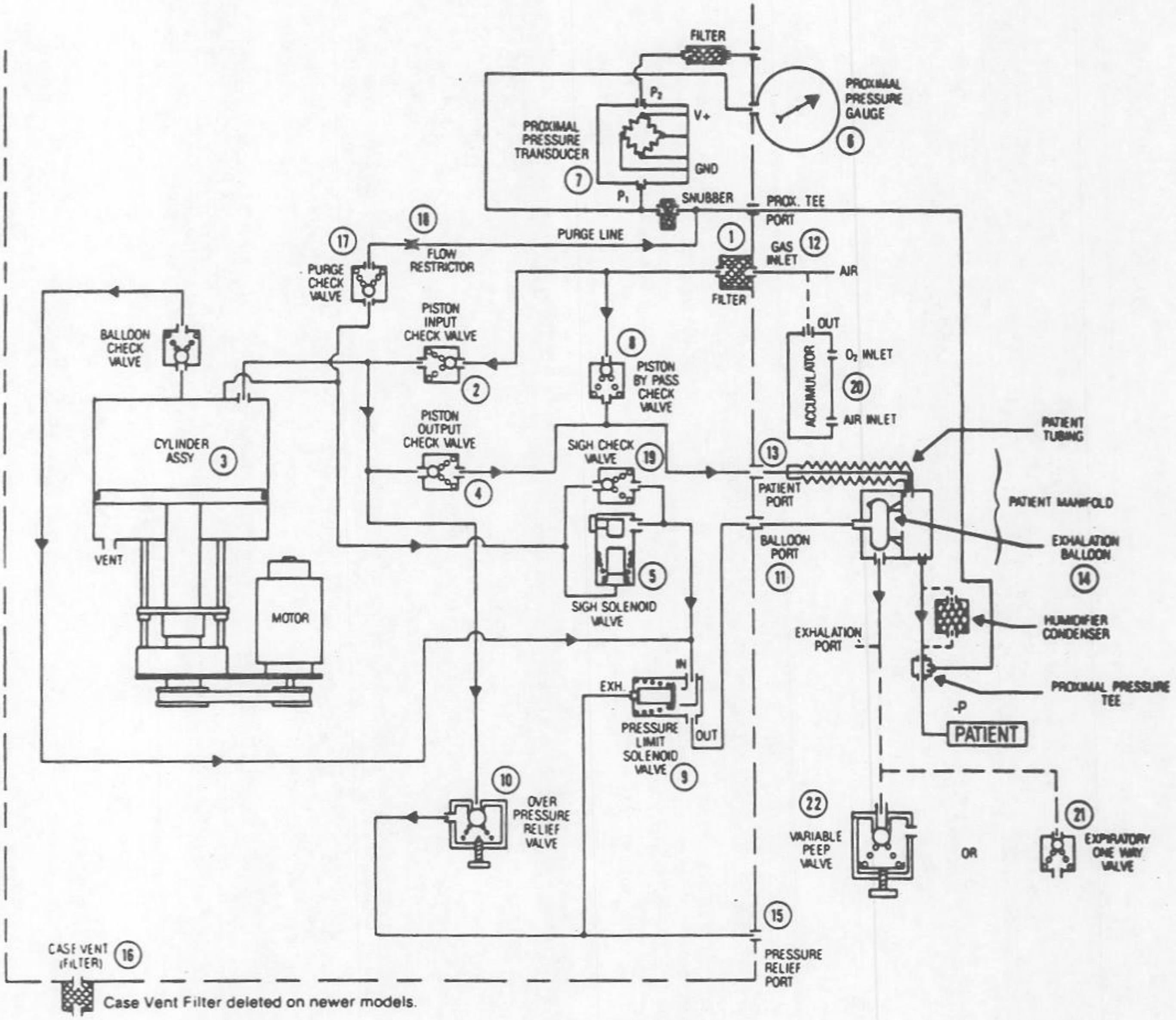


Figure 2-19
SENSOR PCB

Pneumatic System

The BEAR® 33 Volume Ventilator utilizes an electronic control system to govern piston gas delivery to the patient. The pneumatic schematic (Figure 2-20) illustrates all of the major components through which the flow of gas delivered to the patient passes.


FILTER
PROXIMAL PRESSURE GAUGE
6
P₂
V+
PROXIMAL PRESSURE TRANSDUCER
7
GND
P₁
SNUBBER
PROX. TEE PORT
18
17
PURGE LINE
FLOW RESTRICTOR
PURGE CHECK VALVE
1
GAS INLET
12
AIR
FILTER
OUT
ACCUMULATOR
O₂ INLET
20
AIR INLET
BALLOON CHECK VALVE
PISTON INPUT CHECK VALVE
2
8
PISTON BY PASS CHECK VALVE
CYLINDER ASSY
3
PISTON OUTPUT CHECK VALVE
4
SIGH CHECK VALVE
19
13
PATIENT PORT
PATIENT TUBING
PATIENT MANIFOLD
EXHALATION BALLOON
14
BALLOON PORT
11
5
SIGH SOLENOID VALVE
VENT
MOTOR
HUMIDIFIER CONDENSER
EXHALATION PORT
PROXIMAL PRESSURE TEE
IN
EXH.
-P
PATIENT
PRESSURE LIMIT SOLENOID VALVE
9
OUT
10
OVER PRESSURE RELIEF VALVE
22
VARIABLE PEEP VALVE
OR
21
EXPIRATORY ONE WAY VALVE
15
CASE VENT (FILTER)
16
PRESSURE RELIEF PORT

Case Vent Filter deleted on newer models.

Figure 2-20
BEAR® VOLUME VENTILATOR PNEUMATIC SCHEMATIC

1. Gas Inlet Filter – A 59-micron filter to limit the entry of particulate matter into the ventilator.
2. Cylinder Input Check Valve – One-way check valve which permits the air to enter the cylinder when the piston retracts. The valve closes on the forward stroke forcing air to exit through the output check valve.
3. Cylinder Assembly – A 2200 cc maximum displacement piston delivers TIDAL VOLUME or SIGH VOLUME. The piston is driven by a variable speed DC motor in a sinusoidal stroke fashion. The motion of the piston is monitored by a digital encoder. The encoder sends information to the microprocessor which controls piston speed and displacement.

   An end of stroke sensor ("$\overline{\text{HOME}}$" sensor) is used as the primary reference from which displacement is measured.
4. Cylinder Output Check Valve – A one-way check valve which prevents air in the patient circuit from entering the cylinder during the piston's return stroke.
5. Sigh Solenoid Valve – An electronically controlled valve (normally open) through which the exhalation balloon driver pressure must pass. This valve is only actuated when the sigh volume (1.5 V_T) exceeds 2200 ml.

   If the SIGH volume exceed 2200 ml, it is delivered in two parts. On the first stroke, the piston delivers a volume of 2000 cc. At the top of the stroke, the SIGH solenoid closes to maintain pressure in the exhalation balloon and the piston quickly retracts to deliver the remainder of the SIGH volume.
6. Proximal Pressure Gauge – This gauge is connected to the front panel input labeled "PROX. TEE." When a patient circuit is connected, the gauge displays the pressure at the patient interface.
7. Proximal Pressure Transducer – This electronic transducer senses the pressure in the patient manifold and is used for the following functions:
   - High Pressure Alarm
   - Low Pressure Alarm
   - Assist Sensitivity
8. Cylinder Bypass Check Valve – A one-way check valve which allows the patient to spontaneously breathe gas from the ventilator inlet port. This allows the patient to draw spontaneous breaths, even when the piston is retracting for its next delivery (if a one-way valve is installed). However, the patient must overcome circuit/humidifier resistance, as well as reduce PEEP. Cracking pressure of the cylinder bypass valve is 0.2 cmH$_2$O below atmospheric pressure.
9. Pressure Limit Solenoid Valve – This electronically controlled valve is located in the exhalation balloon drive line. When the pressure signal exceeds the HIGH PRESSURE alarm setting, the monitor software causes the valve to open; thereby venting the exhalation balloon.1
10. Overpressure Relief Valve – This pop-off valve is located between the cylinder and cylinder output check valve. This backup safety valve is designed to open only if pressure in the patient circuit exceeds 85 cmH$_2$O. It limits pressure to 125 cmH$_2$O under worst case conditions.
11. Exhalation Balloon Output – A front panel connector (1/8" barb) which allows attachment of the exhalation balloon drive line.
12. Proximal Tee Input – A front panel fitting (3/16" barb) which allows attachment of the proximal airway pressure sensing line.
13. Patient Circuit Output – This is the front panel fitting (3/4" barb) for the patient circuit (labeled "PATIENT").
14. Patient Manifold/Exhalation Balloon – The connections on the patient manifold are:
    - Gas delivery input from the ventilator
    - Gas delivery output to the patient
    - Exhalation balloon connection from ventilator
    - Exhalation port

    The exhalation balloon is located in front of the exhalation port and is normally open (with no pressure applied to the balloon). Pressure applied to the balloon input port on the manifold inflates the balloon and occludes the exhalation port. This causes the gas from the ventilator to be directed to the patient port.
15. Pressure Relief Port – This port connects to the output ports of the OVERPRESSURE RELIEF VALVE and the PRESSURE LIMIT VALVE. The output of the two pressure valves may contain high concentrations of O_2 which cannot be vented to the interior of the cabinet. The port is located in the handle well.
16. Vent Filter – The 59-micron CASE VENT FILTER ensures that the air pumped in and out of the rear of the cylinder mechanism is free of particulate matter.
17. Purge Check Valve – Ensures a unidirectional flow of gas through the proximal pressure line from the cylinder to the proximal pressure tee. This valve keeps moisture from migrating up the Prox Line from the patient to the ventilator.
18. Flow Restrictor – Limits the amount of purge flow received by the proximal pressure line so that the pressure gauge and pressure transducer are not affected by this flow.

19. Sigh Check Valve – Ensures adequate balloon pressure on the second piston stroke of a SIGH volume (when a second stroke is needed).
20. O_2 Accumulator – A mixing chamber which provides a reservoir of mixed gas, from which the cylinder may draw for delivery of increased FIO_2 through the BEAR® 33 Volume Ventilator to the patient.

    Accumulator Outlet – Tubing connects this outlet with the patient air inlet filter port after the filter has been removed and the 1" barb adapter attached.

    Inlet Fitting – This inlet fitting is located adjacent to the reservoir output port and accepts a 5/32" ID tube from any flow controlled O_2 source.

    Accumulator Air Inlet – A filtered inlet which allows entry of room air for mixing with the O_2 supply. This inlet is located at the opposite end of the reservoir from the O_2 inlet and the RESERVOIR OUTLET.
21. Expiratory One-Way Valve – This valve mounts on the exhalation port of the patient manifold and performs two functions:

- When increased FIO_2 is being used, this valve eliminates patient inhalation through the exhalation port from atmosphere while the balloon is deflated during piston retraction.
- When ASSIST SENSITIVITY is being used, the addition of a one-way valve on the exhalation port may enhance the machine's sensitivity to patient inspiratory efforts, since inhalation of atmospheric gas is prevented.

Normal Tidal Volume Delivery

At the end of a delivered breath, the piston is located at the cylinder head. As the piston begins to draw back, the small volume of gas contained in the exhalation balloon is pulled into the cylinder. This opens the exhalation port and allows the patient to exhale. As the piston continues to pull back, the PISTON INPUT CHECK VALVE opens and allows the piston to pull air through the GAS INLET FILTER. The piston will retract to a position determined by the TIDAL VOLUME input shown on the front panel digital display.

When the microprocessor commands delivery of the next positive pressure breath (RATE control or ASSIST SENSITIVITY circuit), the piston drives forward to deliver the TIDAL VOLUME. This delivery of gas to the patient is a sinusoidal waveform and the maximum speed of the piston is determined by the PEAK FLOW setting. As the piston moves forward, pressure begins to rise and immediately inflates the exhalation balloon. The PISTON OUTPUT CHECK VALVE then opens and allows delivery of the TIDAL VOLUME to the patient circuit and the patient (see Figure 2-20). Tidal Volume Accuracy is ±5% or 20 ml, whichever is greater when zero PEEP is used.

Tidal Volume Delivery with PEEP Levels of 1-20 cmH_2O

Tidal Volume is delivered in the same manner as above. However, the presence of positive end expiratory pressure in the patient circuit causes the exhalation balloon to completely deflate, increasing the distance between the balloon and the manifold seat. This can result in some Tidal Volume "blowing by" the balloon during the initial portion of the piston' forward movement resulting in some Tidal Volume loss.

Blow by is compensated for in the BEAR® 33 Ventilator by preferentially biasing flow (during early piston movement) to the exhalation balloon. Generally blow by will increase as Peak Flow and PEEP level increase. However, Tidal Volume will be accurate to within ±10% of the Tidal Volume setting when PEEP is used.

Sigh Volume Delivery

Sigh is activated by the SIGH button and indicated by the SIGH ON indicator. For tidal volumes up to 1460 cc, the SIGH volume function operates exactly as described above. Since $1460 \times 1.5 = 2190$ cc, this is within the capabilities of a single stroke of the piston.

For tidal volumes from 1470 cc to 2200 cc, the corresponding SIGH volumes are 2205 cc to 3300 cc and these are beyond the capability of a single stroke of the piston.

To achieve a SIGH volume beyond the capability of a single piston stroke, the ventilator will deliver two piston strokes, the sum of which is the desired SIGH volume. To accomplish this two-stroke delivery of SIGH volume, a first stroke of the piston delivers 2000 cc. The piston will then quickly pull back with a second stroke, and deliver the remainder of the appropriate SIGH volume.

35

Example

Tidal volume = 1500 cc
Calculated SIGH = 2250 cc

Therefore:

First Piston Stroke = 2000 cc
Second Piston Stroke = 250 cc

Total Sigh Delivered = 2250 cc

To accomplish this double stroke delivery of SIGH volume, the SIGH solenoid valve is closed during the piston pull back and the second stroke. The closure of this valve keeps a positive pressure in the exhalation balloon during the pull back, maintaining patient pressure. The second piston stroke delivers gas to the exhalation balloon through the SIGH CHECK VALVE, thus keeping the exhalation valve closed during the second stroke. At the end of the second stroke on a SIGH volume, the SIGH SOLENOID is opened and the normal TIDAL VOLUME delivery is resumed.

The SIGH expiratory time is automatically adjusted to 1.5 x the normal rate determined expiratory time. This allows adequate exhalation of the SIGH breath. The rate window will be shifted as a result. High Pressure Limit will increase by 1.5 times the normal set value, but in no case will it exceed 80 cmH$_2$O. This is to allow for the increased pressure due to the volume increase.

Spontaneous Breathing

With the standard BEAR® 33 Volume Ventilator patient manifold (no one-way exhalation valve), the patient has two sources of gas available for spontaneous inhalation. The patient may inhale past the deflated exhalation balloon from atmosphere or through the cylinder bypass check valve in the ventilator. Inhalation will pull from one or both sources, depending on the effort.

If an expiratory one-way valve is added to the exhalation port of the patient manifold, then the patient inhalation will come solely from the ventilator. When the patient draws solely from the ventilator, the majority of this inhalation will come through the cylinder bypass check valve. Some gas may be pulled through the cylinder input and output valves. The primary reason for the cylinder bypass check valve is to allow the patient to inhale spontaneously during the time period that the piston is pulling back in preparation for the next positive pressure breath.

Spontaneous Breathing with PEEP

The BEAR® 33 Ventilator does not incorporate an pneumatic demand valve, leak compensation or PEEP make-up features. Thus, when PEEP is added to the patient circuit, the patient must be capable of reducing the baseline pressure to the cracking pressure of the cylinder bypass check valve in order to spontaneously breathe. The cylinder bypass check valve cracks at -0.2 cmH$_2$O. PEEP may lead to increased work of breathing, and may be beyond the capabilities of some patients. Thus, it is important to evaluate the need for PEEP in light of the patient's ability to perform work of breathing.

High Pressure Alarms and Limit

The primary system which limits high pressure conditions is the front panel HIGH PRESSURE ALARM, including the proximal pressure transducer and the pressure limit solenoid. Any time the pressure transducer senses a pressure higher than the High Pressure alarm setting, the monitor software will activate the PRESSURE LIMIT SOLENOID VALVE which vents exhalation balloon pressure and thus, the patient circuit pressure. The monitor software will simultaneously stop the forward motion of the piston until the pressure falls below the Low Pressure alarm setting. The piston will then move to the home position with the exhalation balloon remaining open. After the activation of the HIGH PRESS indicator, the pressure is monitored. If the pressure does not decrease below the LOW PRESS ALARM setting within three (3) seconds, the audible alarm will latch on.

When the proximal pressure has reduced to the LOW PRESSURE alarm setting and the piston has reached home, the pressure limit solenoid will close and allow the ventilator to deliver any succeeding positive pressure breaths.

NOTE

If the proximal pressure exceeds 80 cmH$_2$O, the HIGH PRESSURE visual and audible alarm will latch on upon the first occurrence. This differs from the normal high pressure alarms (below 80 cmH$_2$O) violation which requires two occurrences to latch on to the audible portion of the alarm.

Overpressure Relief Valve

The OVERPRESSURE RELIEF VALVE is a backup to the HIGH PRESSURE ALARM/LIMIT system. Should that system fail and allow inspiratory pressures to exceed 85 cmH$_2$O, this valve will open. Peak pressure attained in the patient circuit will be limited to a maximum of 125 cmH$_2$O (at 120 LPM flow rate).

Pressure Relief Port

The outputs of the PRESSURE LIMIT SOLENOID VALVE and OVERPRESSURE RELIEF VALVE are connected to the PRESSURE RELIEF PORT which is located in the ventilator handle well. This ensures that any ventilator gas is dumped outside the ventilator case to prevent possible high O_2 concentrations within the case.

SECTION 3

BEAR® 33 VOLUME VENTILATOR

OPERATIONAL VERIFICATION PROCEDURE

OPERATIONAL VERIFICATION PROCEDURE (OVP)

The purpose of this procedure is to assist a Qualified Clinician, Hospital Service Technician or Bear Medical Systems Service Technician in establishing a routine verification program which will assist in assuring that the BEAR® 33 Volume Ventilator is in proper operating condition. A checklist is included and should be completed during each operational verification.

A copy of the complete checklist should be kept on file for future reference. The attached checklist may be copied, providing forms for future use.

Familiarity with the function, set-up and operation of the BEAR® 33 Volume Ventilator is assumed (see BEAR® 33 Volume Ventilator Instruction Manual). Perform all tests in the following sequence.

VERIFICATION PROGRAM

Optional Verification should be performed a minimum of once each month.

Certain procedures such as the Oxygen % check, (if applicable), the Display and Alarm Test, and the System Leak Test should be performed at least once every 24 hours that the unit is in clinical use.

Do not use the ventilator unless it passes the Operational Verification Procedure. For servicing, contact a Bear Medical Systems Service Technician, a Bear Medical Systems authorized servicing dealer, or a Bear Medical Systems Trained Hospital Service Technician.

TEST EQUIPMENT REQUIRED

Equipment	Recommended Supplier
Pressure Gauge, 0-150 cmH2O ±1% F/S	Marshalltown Model 86F, with scale in cmH2O, Wallance and Tierman Model FA 14170 or equivalent
Spirometer, water seal	Collins or equivalent
Stopwatch	General purpose
Test Lung	Manley or equivalent
Remote Alarm (if applicable)	Bear Medical Systems P/N 51000-08131
Valve, One-Way	Bear Medical Systems P/N 51000-08118
Mainflow Bacteria Filter	Bear Medical Systems P/N 51000-01054

WARNING

THE FOLLOWING WARNINGS MUST BE READ AND UNDERSTOOD BEFORE PERFORMING ANY OF THE PROCEDURES DESCRIBED IN THIS SECTION.

- UNDER NO CIRCUMSTANCES SHOULD THIS MEDICAL DEVICE BE OPERATED IN THE PRESENCE OF FLAMMABLE ANESTHETICS OR OTHER VOLATILE MATERIALS DUE TO A POSSIBLE EXPLOSION HAZARD.
- LIQUID SPILLED OR DRIPPED INTO THE UNIT MAY CAUSE DAMAGE TO THE UNIT OR RESULT IN AN ELECTRICAL SHOCK HAZARD.
- OXYGEN VIGOROUSLY ACCELERATES COMBUSTION. TO AVOID VIOLENT IGNITION, DO NOT USE ANY GAUGES, VALVES, OR OTHER EQUIPMENT THAT HAS BEEN EXPOSED TO OIL OR GREASE CONTAMINATION.
- DO NOT RELEASE THIS MEDICAL DEVICE IF ANY ALARM/ALERT FUNCTION IS INOPERATIVE. TO DO SO COULD RESULT IN A MALFUNCTION WITHOUT WARNING, POSSIBLY RESULTING IN PERSONAL INJURY, DEATH OR PROPERTY DAMAGE. REFER THE UNIT TO A BEAR MEDICAL SYSTEMS AUTHORIZED SERVICE TECHNICIAN OR A BEAR MEDICAL SYSTEMS TRAINED HOSPITAL SERVICE TECHNICIAN.
- ALL TUBING AND FITTINGS USED TO CONNECT HIGH PRESSURE GAS (AIR AND OXYGEN) FROM THE SOURCE TO THE TEST EQUIPMENT AND FROM THE TEST EQUIPMENT TO THE DEVICE TO BE TESTED MUST BE CAPABLE OF WITHSTANDING 100 PSI (7.03kg/cm^2). THE USE OF TUBING AND FITTINGS NOT CAPABLE OF WITHSTANDING THIS PRESSURE COULD CAUSE THE TUBING TO RUPTURE, RESULTING IN PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.
- WHEN VERIFYING THE OPERATION OF THIS MEDICAL DEVICE, DO NOT BREATHE DIRECTLY FROM THE MACHINE. ALWAYS USE A FRESH BACTERIAL FILTER AND TEST CIRCUIT. A HAZARD TO THE HEALTH OF THE SERVICE PERSON MAY RESULT.
- IF ANY OF THE FOLLOWING PROCEDURES CANNOT BE VERIFIED AS OUTLINED IN THIS DOCUMENT, DISCONNECT THIS MEDICAL DEVICE AND REFER IT TO BEAR MEDICAL SYSTEMS OR A BEAR MEDICAL SYSTEMS AUTHORIZED SERVICE FACILITY OR A BEAR MEDICAL SYSTEMS TRAINED HOSPITAL SERVICE TECHNICIAN.

CAUTIONS

The following CAUTIONS must be read and understood before performing any of the procedures described in this section.

- DO NOT USE MEK OR TRICHLOROETHYLENE, AS DAMAGE TO SURFACES MAY RESULT. DO NOT ALLOW ANY LIQUID TO SPILL OR DRIP INTO THE VENTILATOR.
- DO NOT GAS STERILIZE THE VENTILATOR; THE INTERNAL MATERIALS ARE NOT COMPATIBLE WITH GAS STERILIZATION TECHNIQUES.
- BEFORE USING ANY TEST EQUIPMENT (ELECTRONIC OR PNEUMATIC) FOR CALIBRATION PROCEDURES (OTHER THAN OPERATIONAL VERIFICATION), THE ACCURACY OF THE INSTRUMENTS MUST BE CERTIFIED BY A TESTING LABORATORY. THE LABORATORY MASTER TEST INSTRUMENTS MUST BE TRACEABLE TO THE US BUREAU OF STANDARDS OR EQUIVALENT. WHEN VARIANCES EXIST BETWEEN THE INDICATED AND ACTUAL VALUES, THE CALIBRATION CURVES (PROVIDED FOR EACH INSTRUMENT BY THE TESTING LABORATORY) MUST BE USED TO ESTABLISH THE ACTUAL CORRECT VALUES. THIS CERTIFICATION PROCEDURE SHOULD BE PERFORMED AT LEAST ONCE EVERY SIX MONTHS. MORE FREQUENT CERTIFICATION MAY BE REQUIRED BASED ON USAGE AND ENVIRONMENT.

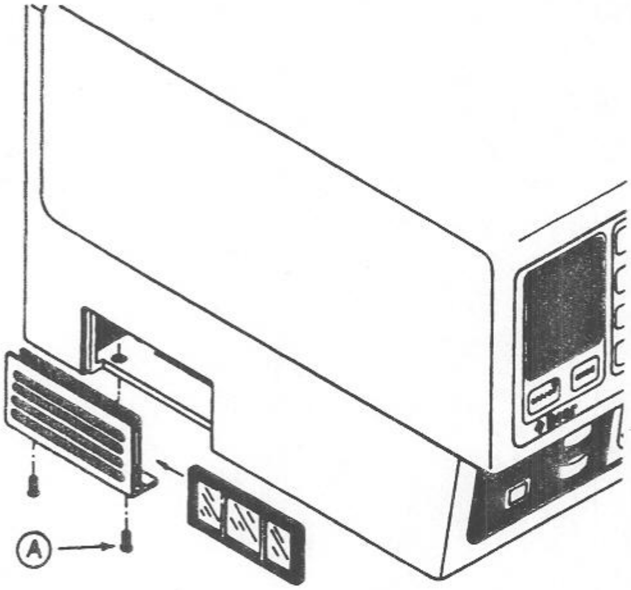


Figure 3-1B
CASE INLET FILTER

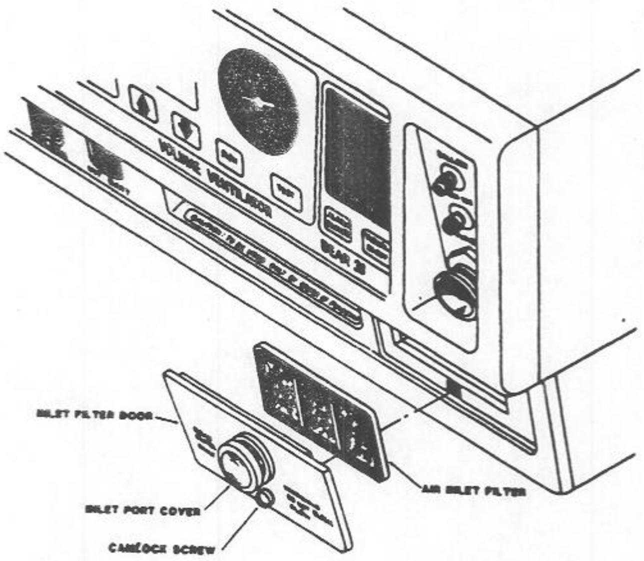


Figure 3-1C
PATIENT AIR INLET FILTER

CASE INLET FILTER (Older units only)

Removal Procedure

1. Remove all tubing connected to the ventilator.
2. Position the ventilator to access and remove the two screws on the left side of the ventilator base (Figure 3-1B).
3. Slide the flush mount filter retainer door away from the ventilator housing.
4. Remove the filter from the slot in the filter retainer door. Clean the filter by washing with water and a mild detergent.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.

PATIENT AIR INLET FILTER

Removal Procedure

1. Using an ordinary screwdriver, loosen the screw on the INLET FILTER door (see Figure 3-1C). The screw is captive.
2. Grasp the INLET PORT COVER, pull the door free and set it aside.
3. Remove the AIR INLET FILTER by gently pulling it out of its tight recess. Clean the filter by washing with water and a mild detergent.

Replacement Procedure

After cleaning the filter or substituing a new unit, replacement may be accomplished by reversing the removal procedure.

EXTERIOR INSPECTION AND CLEANING

Inspection

Inspect all cords, connectors and fittings. Inspect the housing for cracks or other damage.

Cleaning

1. Before any cleaning of the ventilator, disconnect WALL AC and EXTERNAL BATTERY power sources.
2. Clean the exterior of the ventilator with alcohol. Care should be exercised not to allow any liquid to penetrate the inside of the ventilator.

CAUTION

DO NOT GAS STERILIZE OR STEAM AUTOCLAVE THE VENTILATOR

PATIENT CIRCUIT

1. The entire patient circuit system should be cleaned at least two times per week or following each patient use. All items of the patient circuit, except for the artificial nose or any inline thermometer, should be cleaned with a warm soap and water solution, thoroughly rinsed with warm water and air dried.

The following parts are necessary in the patient circuit system:

Patient Circuit Tubing
Exhalation Valve Tubing
Proximal Pressure Tubing
Proximal Pressure Tee
Flex Tube
Patient Manifold

2. Disassemble and clean the patient manifold in accordance with Section 8, BEAR® 33 Volume Ventilator Clinical Instruction Manual. Inspect:
   - Manifold housing for cracks
   - Exhalation balloon for cuts
   - Exhalation valve seal for damage.

Reassemble manifold with special attention to the Balloon Port Gasket (Figure 3-1A, item 1). Make sure the gasket is seated properly and the Balloon Port Housing (item 2) is lightly hand tightened.

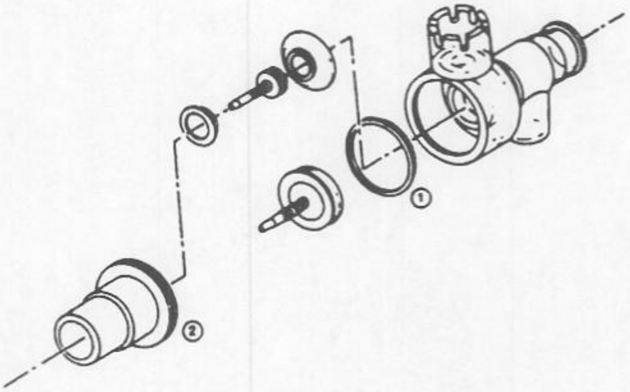


Figure 3-1A
PATIENT MANIFOLD

CAUTION

DO NOT OVERTIGHTEN THE HOUSING.

FILTERS

The Air Inlet and Case inlet filters are easily accessible for removal and cleaning. They may be washed in a warm soap and water solution, thoroughly rised with warm water and air dried.

NOTE

Newer units do not have case inlet filters.

CAUTION

DO NOT OPERATE THE VENTILATOR WITHOUT THE FILTERS IN PLACE.

PLUGS AND CABLES

Plugs and cables may be wiped down with alcohol.

STANDARD SETTINGS FOR OVP

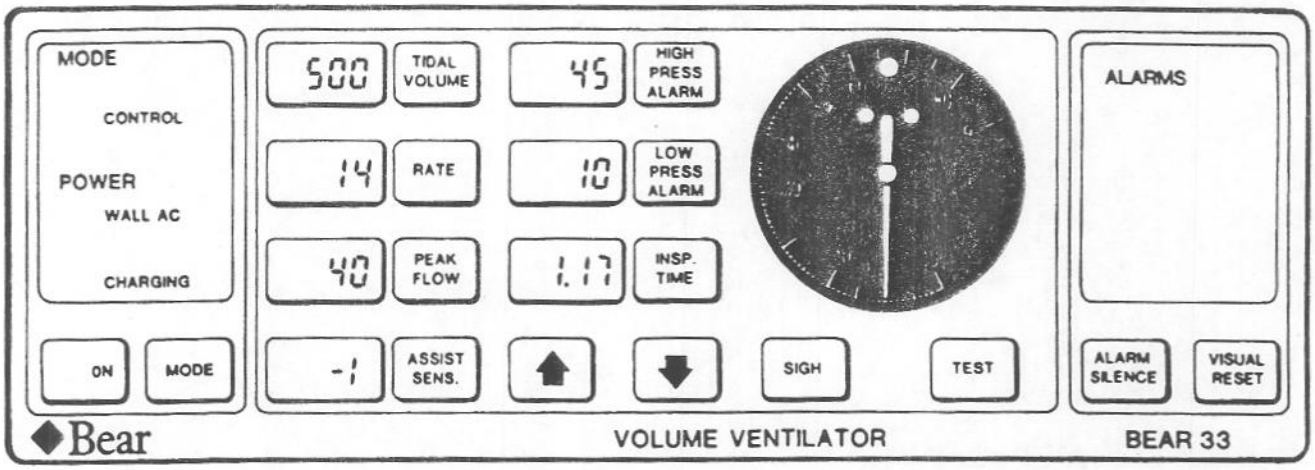

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-2

SETUP PROCEDURE

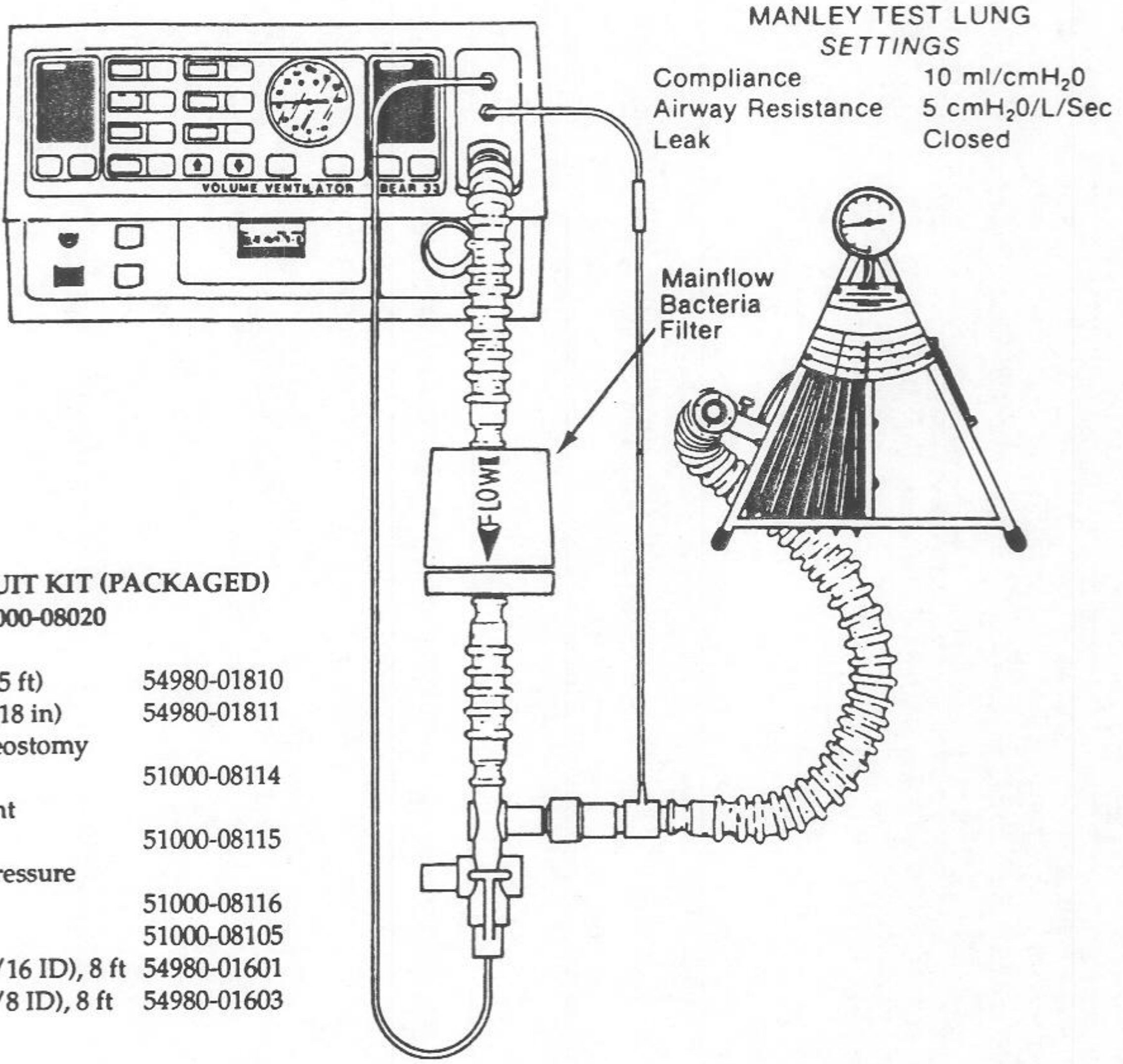
1. Provide an alternate means of ventilation for the patient and disconnect the ventilator to be tested.
2. Connect the STANDARD OVP TEST CIRCUIT as in Figure 3-3. Adjust the Manley Test Lung (if used) for the settings of Compliance, Airway Resistance, and Leak as indicated on Figure 3-3. If an alternate lung is used, make equivalent settings on that device.
3. Connect the ventilator to an active source of AC power. Depress the ON/OFF button to turn the unit ON.

NOTE

The UNLOCK button must be depressed once before changing panel settings or turning the unit off. The panel controls will remain unlocked for 15 seconds after the last panel entry, then they automatically re-lock.

4. UNLOCK the front panel and depress the MODE button as many times as necessary to get a MODE display of CONTROL.
5. Depress the TIDAL VOLUME LCD button and simultaneously depress the UP or DOWN button to change the display. When the display reads 500, release the UP (or DOWN) button, then release the TIDAL VOLUME button.
6. Repeat step 5 for RATE, PEAK FLOW, ASSIST SENS., HIGH PRESS ALARM, and LOW PRESS ALARM. Set each display for the STANDARD SETTING value indicated in Figure 3-2. Verify that the Insp. Time display reads as indicated.

STANDARD OVP TEST CIRCUIT



MANLEY TEST LUNG

SETTINGS

Compliance	10 ml/cmH$_2$0
Airway Resistance	5 cmH$_2$0/L/Sec
Leak	Closed

PATIENT CIRCUIT KIT (PACKAGED)

51000-08020

1.	Patient Tubing (5 ft)	54980-01810
2.	Patient Tubing (18 in)	54980-01811
3.	Flextube, Tracheostomy (Packaged)	51000-08114
4.	Manifold, Patient (Packaged)	51000-08115
5.	Tee, Proximal Pressure (Packaged)	51000-08116
6.	Clip, Tubing	51000-08105
7.	Tubing, PVC (3/16 ID), 8 ft	54980-01601
8.	Tubing, PVC (1/8 ID), 8 ft	54980-01603

THIS TEST CIRCUIT WILL BE USED FOR ALL OPERATIONAL VERIFICATION (OVP) TESTS UNLESS OTHERWISE SPECIFIED.

Figure 3-3

DISPLAY READINGS FOR DISPLAY AND ALARM TEST

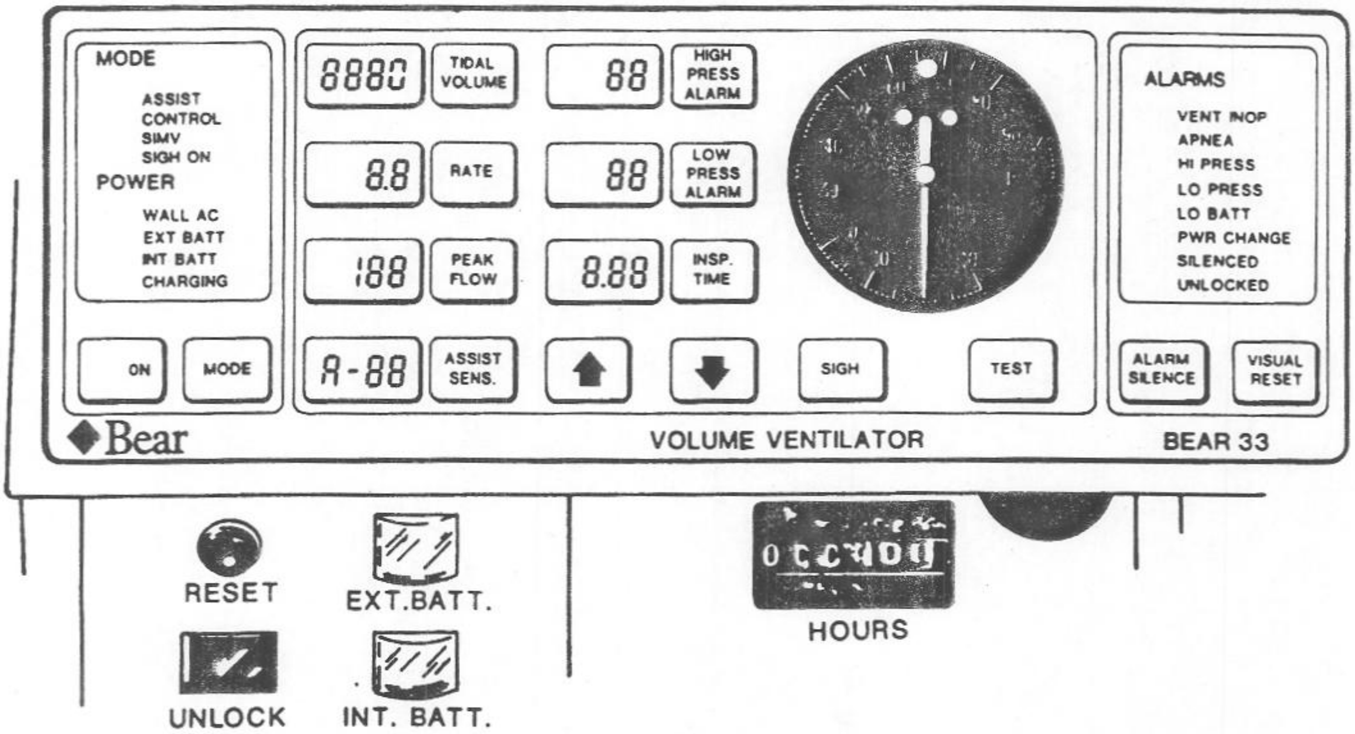

MODE
ASSIST
CONTROL
SIMV
SIGH ON
POWER
WALL AC
EXT BATT
INT BATT
CHARGING
ON
MODE
8880
TIDAL VOLUME
8.8
RATE
188
PEAK FLOW
A-88
ASSIST SENS.
88
HIGH PRESS ALARM
88
LOW PRESS ALARM
8.88
INSP. TIME
SIGH
TEST
ALARMS
VENT INOP
APNEA
HI PRESS
LO PRESS
LO BATT
PWR CHANGE
SILENCED
UNLOCKED
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
RESET
EXT.BATT.
UNLOCK
INT. BATT.
HOURS

Figure 3-4

DISPLAY AND ALARM TEST

1. Unplug the ventilator from AC power and depress the power ON/OFF button to turn the unit ON. Verify that the INT BATT power display is illuminated and the INT. BATT. meter indicator is in the green area.
2. Wait at least five seconds after power turn on, then depress and hold the TEST button.
3. Carefully examine each LCD display and verify that every individual segment and decimal point illuminates the LCDs as shown in Figure 3-4.
4. Verify that all MODE, POWER and ALARM LED displays are illuminated and the audible alarm is sounding (Figure 3-4).
5. Release the TEST button and connect the REMOTE ALARM (if applicable) by plugging it into the appropriate jack in the back of the ventilator. Again depress the TEST button and verify operation of the REMOTE ALARM.
6. Check the appropriate block on the OVP checklist.

POWER-UP DISPLAY TEST

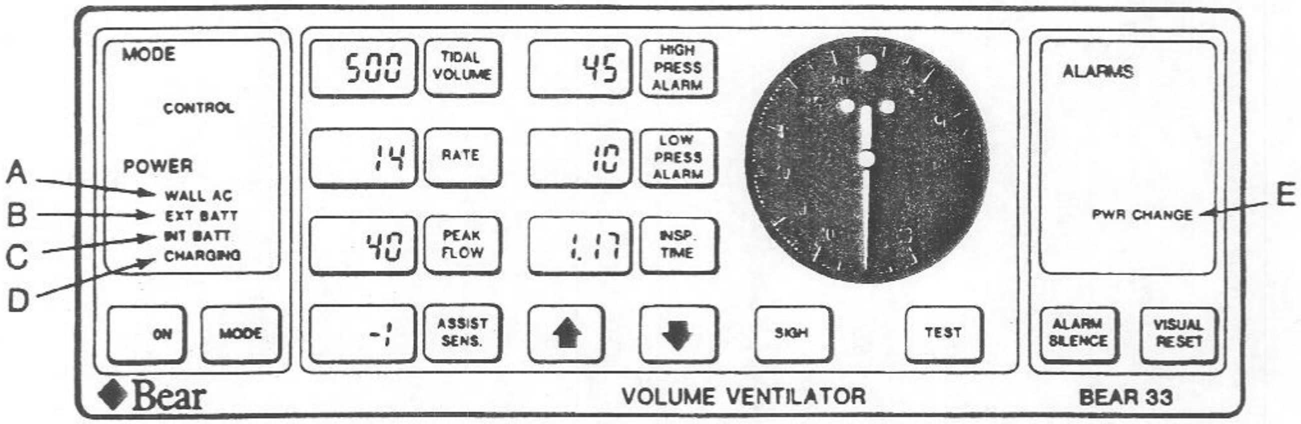

MODE
CONTROL
POWER
WALL AC
EXT BATT
INT BATT
CHARGING
A
B
C
D
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
PWR CHANGE
E
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-5

POWER-UP TEST

1. Connect the ventilator to an AC power source. Depress the ON/OFF button to turn the ventilator ON. Verify that the WALL AC (Figure 3-5, Item A) and CHARGING LED (Item D) displays are illuminated.
2. Connect the ventilator to an appropriate external 12 VDC power source using External Battery Cable (Bear Medical Systems P/N 51000-08127 or 51000-08129).
3. Disconnect the AC power cord from the AC power source and verify the following:
   a. The WALL AC LED display is OFF and the EXT BATT LED display (Item B) is illuminated.
   b. An audible alarm sounds and the PWR CHANGE ALARM LED display (Item E) is illuminated and flashing.
   c. Depressing the ALARM SILENCE button turns off the audible alarm; a second depression reactivates the audible alarm.
   d. Both the audible alarm and the PWR CHANGE ALARM LED display (Item E) are cancelled by depressing the VISUAL RESET button.
   e. If the external battery source is fully charged, the EXT BATT meter indicator is in the green area of the meter.
4. Disconnect the external battery power source and verify the following:
   a. The EXT BATT LED display (Item B) is OFF and the INT BATT LED display (Item C) is illuminated.
   b. An audible alarm sounds and the PWR CHANGE ALARM LED display (Item E) is illuminated and flashing.
   c. Depressing the ALARM SILENCE button turns off the audible alarm; a second depression reactivates the audible alarm.
   d. Both the audible alarm and the PWR CHANGE ALARM LED display (Item E) are cancelled by depressing the VISUAL RESET button.
   e. The INT BATT meter indicator is in the green area of the meter.
5. Reconnect the AC power cord removed in Step 3 and verify the following:
   a. The INT BATT LED display (Item C) is OFF and the WALL AC LED display (Item A) is illuminated.
   b. Unlock the front panel and depress the ON/OFF button to turn the ventilator OFF. Verify that the CHARGING display (Item D) is illuminated.
6. Check the appropriate block on the OVP checklist.

DISPLAY SETTINGS FOR SYSTEMS LEAK TEST

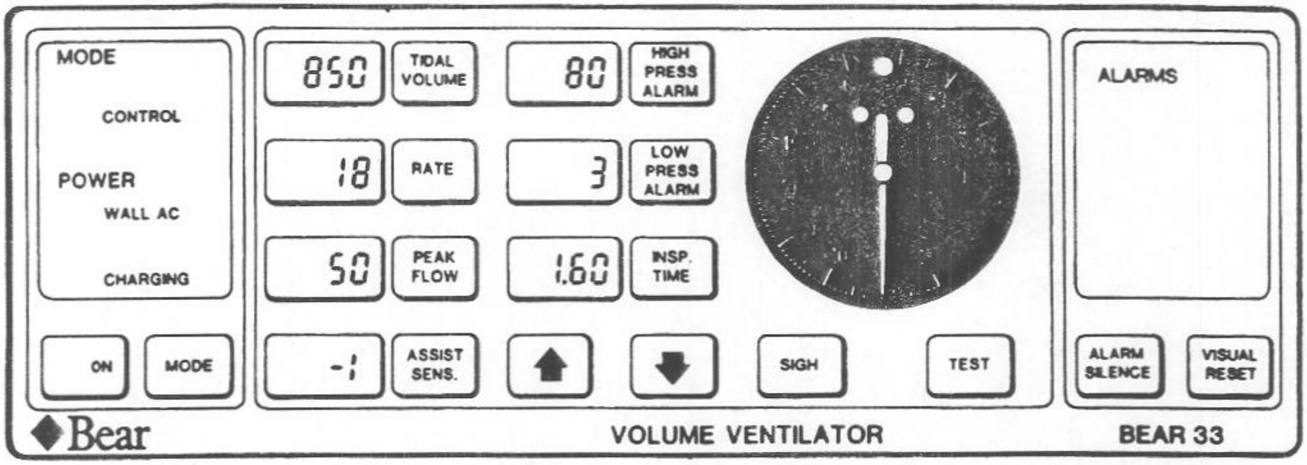

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
850
TIDAL VOLUME
18
RATE
50
PEAK FLOW
-1
ASSIST SENS.
80
HIGH PRESS ALARM
3
LOW PRESS ALARM
1.60
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
◆Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-6A

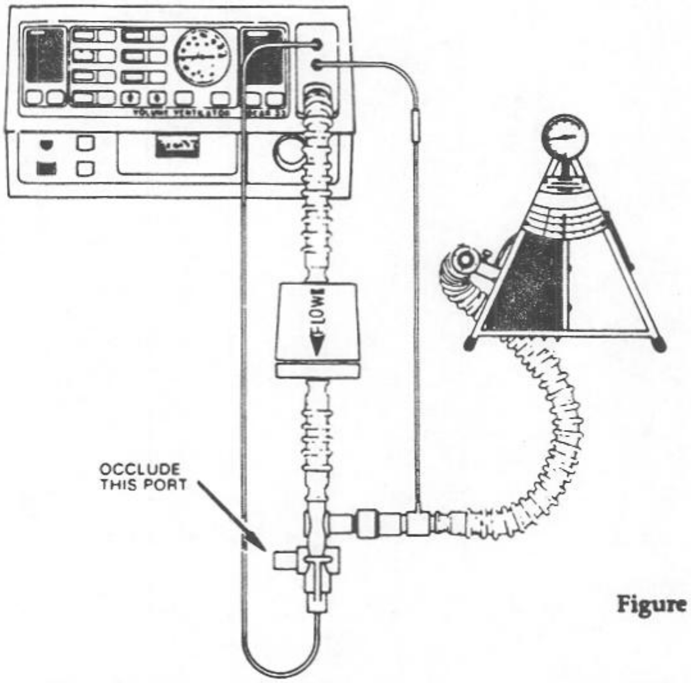

FLOW
OCCLUDE THIS PORT

Figure 3-6B

SYSTEM LEAK TEST

1. With the ventilator connected to an AC power source, depress the ON/OFF button to turn the ventilator ON. UNLOCK the panel and set the displays to the values indicated in Figure 3-6A.
2. Observe the PROXIMAL AIRWAY PRESSURE GAUGE. When the gauges reaches peak pressure, occlude the EXHALATION PORT using a check valve or by other means (see Figure 3-6B).
3. Read the peak inspiratory pressure on the PROXIMAL AIRWAY PRESSURE GAUGE and verify that the pressure does not decrease by more than 10 cmH_2O before the next inspiratory cycle starts.

NOTE

Ignore the APNEA alarm and LED display that may occur during this test.

4. If the system fails this test, recheck all patient circuit connections for air seal, hose cracks, cuts, or other leaks. Check that the gasket in the patient manifold is in place and properly seated, then repeat steps 2 and 3.
5. Clear the EXHALATION PORT at the completion of this test.
6. Check the appropriate block on the OVP checklist.

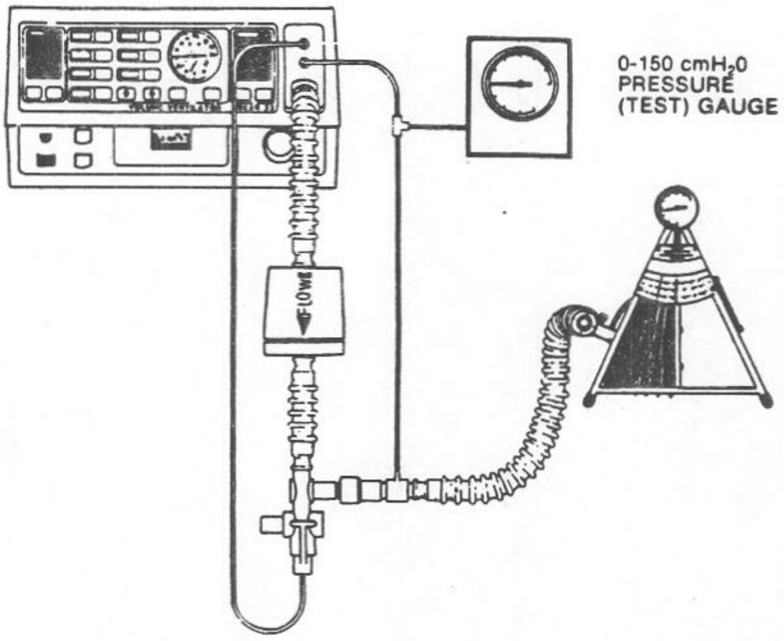


Figure 3-6C

7. Set the Manley Tet Lung with 3 springs, R=200.
8. Connect a 0-150 cmH_2O Pressure Test gauge into the PROXIMAL PRESSURE SENSING LINE as indicated in Figure 3-6C.
9. Set the following parameters:
   Tidal Volume – 500 ml
   Breath Rate –5 BPM
   Peak Flow – 20 LPM
   High Pressure Alarm – 80 cmH_2O
   Low Pressure Alarm – 10 cmH_2O
   Sigh – Off
10. Observe the baseline pressure for 10 breaths using the 0-150 cmH_2O gauge. Baseline pressure may not be higher than 1.0 cmH_2O.
11. Check the appropriate block on the OVP checklist.

DISPLAY SETTINGS FOR CONTROL MODE TEST

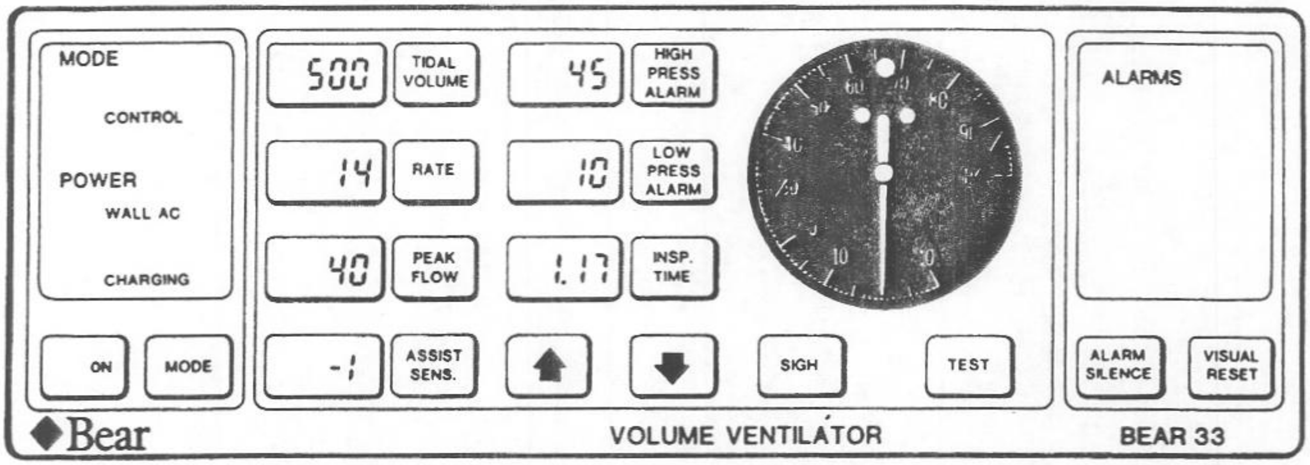

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-7A

CONTROL MODE TEST

1. UNLOCK the front panel and set the displays to the STANDARD SETTINGS as in Figure 7A. Allow the ventilator to cycle at least twice to stabilize all functions.
2. Visually verify that the test lung is expanding with each breath delivered and contracting during the exhalation phase.
3. Verify that spontaneous breaths may be drawn by pulling or expanding the test lung (Figure 7B) between breaths. Note that the PROXIMAL AIRWAY PRESSURE GAUGE may deflect briefly in the negative direction when a negative pressure is created by expanding the test lung.
4. Verify that an "A" does appear in the ASSIST SENS. LCD display when the test lung is expanded, but an assisted breath does not occur.
5. Check the appropriate block on the OVP checklist.

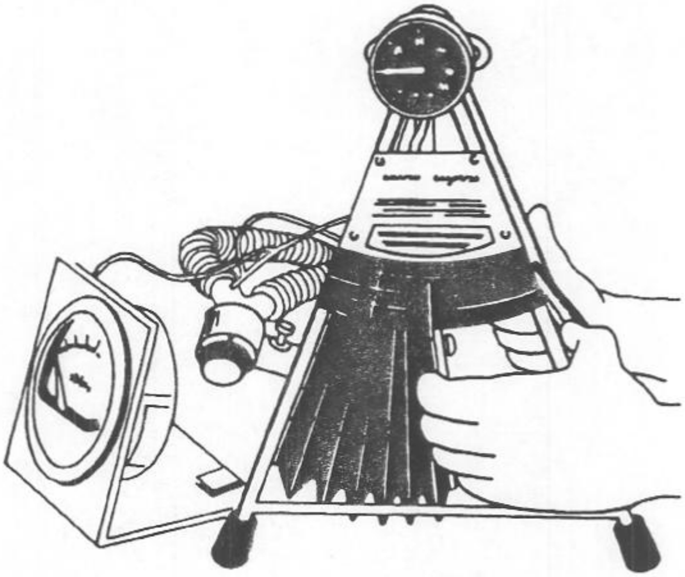


Figure 3-7B

DISPLAY SETTINGS FOR ASSIST CONTROL MODE TEST

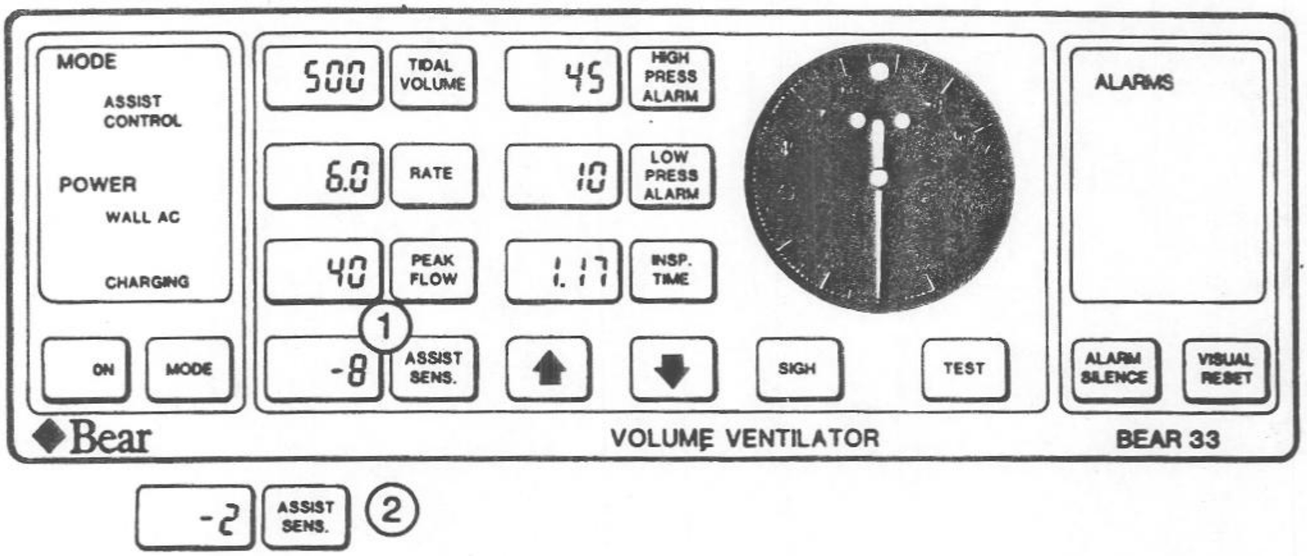

MODE
ASSIST
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
6.0
RATE
40
PEAK FLOW
-8
ASSIST SENS.
1
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
-2
ASSIST SENS.
2

Figure 3-8A

ASSIST CONTROL MODE TEST

1. UNLOCK the panel and set all displays to the initial values indicated in Figure 3-8A.
2. Allow the ventilator to cycle at least twice to stabilize all functions.
3. Fully expand the test lung bellows immediately after a positive pressure breath has been delivered (Figure 3-8B). Verify that an "A" appears briefly at the left side of the ASSIST SENS. LCD display.

NOTE

Ignore the HI PRESS LED and alarm that may result.

NOTE

Do not expand a Manley Test Lung until it has stabilized at 0.00.

4. Verify that an assisted breath is delivered.
5. Again UNLOCK the front panel and reset the ASSIST SENS. display to -2 cmH_2O (Figure 3-8A, Item 2).
6. Create a negative pressure as in Step 3, but only slightly expand the Test Lung bellows. Again, verify that an "A" appears at the left side of the ASSIST SENS. LCD display and an assisted breath is delivered.
7. Set the ASSIST SENS. display to 5 cmH_2O and verify that autocycling occurs. Autocycling is recognized by the brief appearance of an "A" in the display and simultaneous delivery of a breath on every cycle.

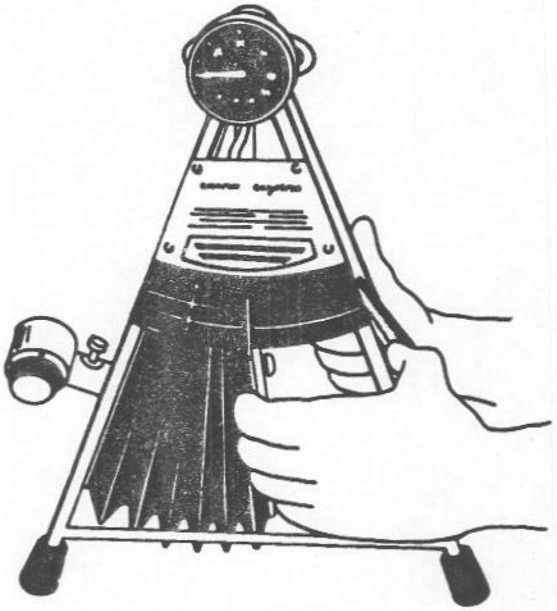


Figure 3-8B

Decrease the setting of the ASSIST SENS. display one step at a time (i.e., 4, 3, 2, etc.) to -1 cmH_2O. Verify that autocycling does occur at each display setting down to and including 1 cmH_2O. Verify that autocycling does not occur at -1 cmH_2O. Autocycling may or may not occur at 0 cmH_2O.

DISPLAY SETTINGS FOR SIMV MODE TEST

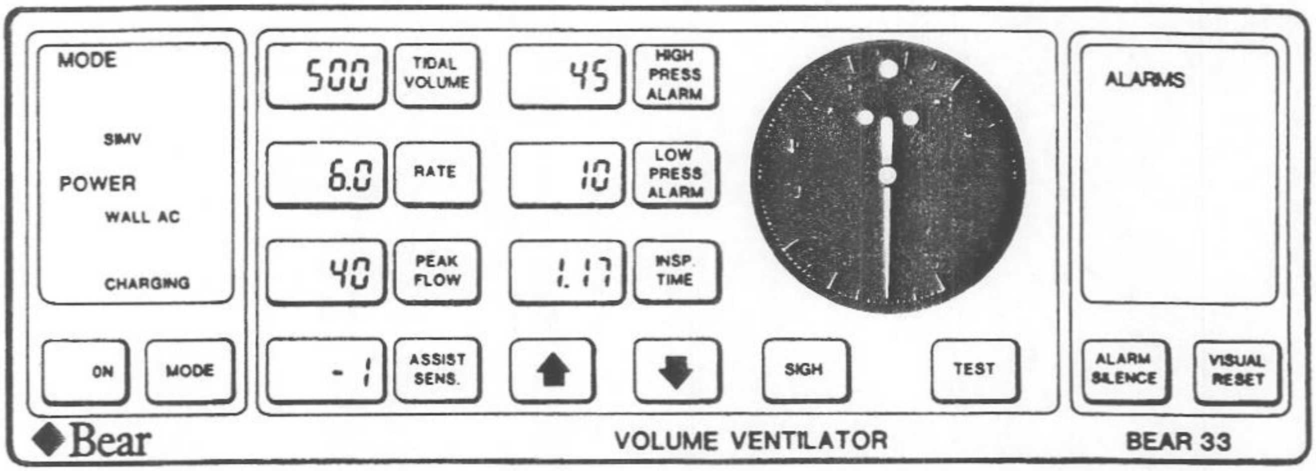

MODE
SIMV
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
6.0
RATE
40
PEAK FLOW
- 1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
◆Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-9A

SIMV MODE TEST

1. UNLOCK the panel and set all displays to the initial values indicated in Figure 3-9A. Allow the ventilator to cycle at least twice to stabilize all functions.
2. Expand the Test Lung (Figure 3-9B) to verify that a single ASSISTED breath, then consecutive spontaneous breaths, can be produced by pulling the bellows plate to expand the bellows.
3. Verify spontaneous breaths by continuing to periodically "pull" on the Test Lung until the next time period allows an ASSISTED breath.
4. Check the appropriate block on the OVP checklist.

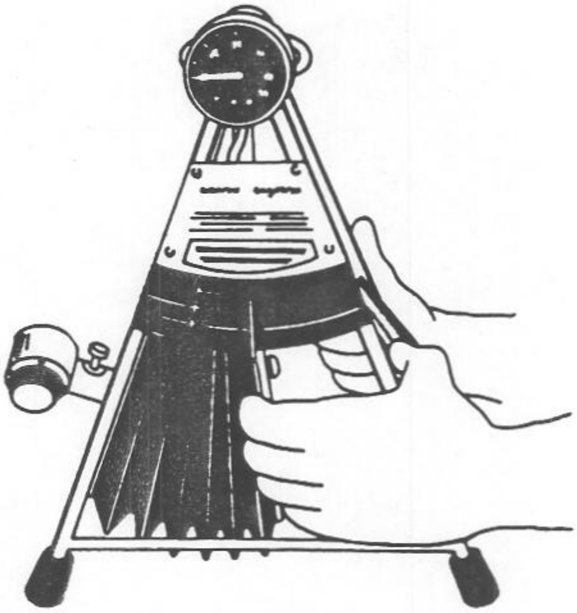


Figure 3-9B

DISPLAY SETTINGS FOR SIGH FUNCTION TEST

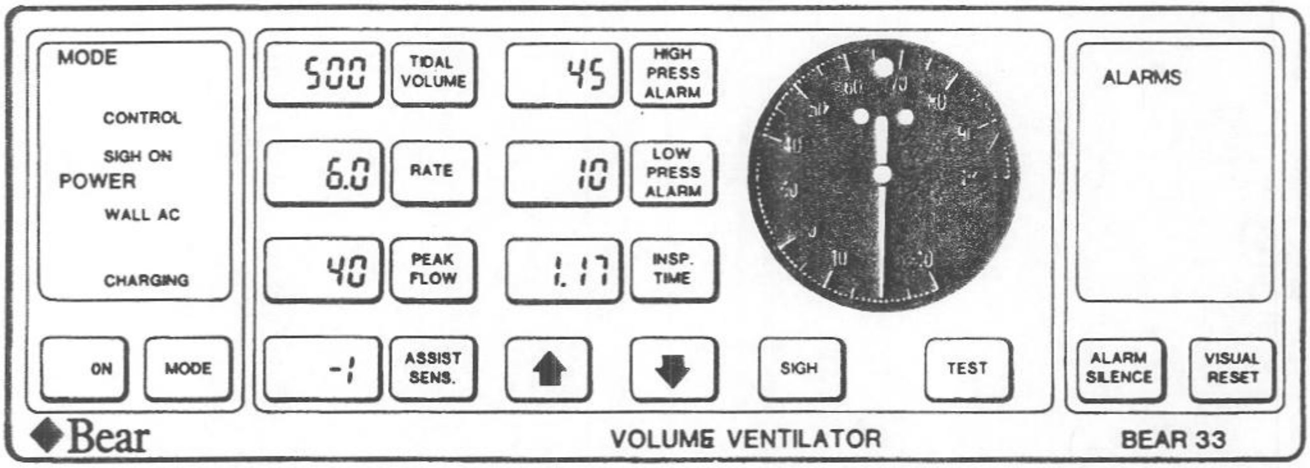

MODE
CONTROL
SIGH ON
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
6.0
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-10

SIGH FUNCTION TEST

1. UNLOCK the front panel and set all displays to the initial values indicated in Figure 3-10. Allow the ventilator to cycle at least twice to stabilize all functions.
2. Again UNLOCK the panel and depress the SIGH button. Verify the following:
   a. The SIGH ON LED illuminates
   b. A sigh breath is delivered as indicated by the increased deflection of the PROXIMAL AIRWAY PRESSURE gauge. Since sigh breaths have 1.5 times normal tidal volumes, proximal pressure should be approximately 1.5 times normal at the end of volume delivery.
   c. The SIGH ON LED blinks momentarily during the sigh breath.
3. Check the appropriate block on the OVP checklist.

NOTE

There will be a 1-2 breath delay after depressing the SIGH button before the SIGH BREATH is delivered.

DISPLAY SETTINGS FOR TIDAL VOLUME DISPLAY TEST

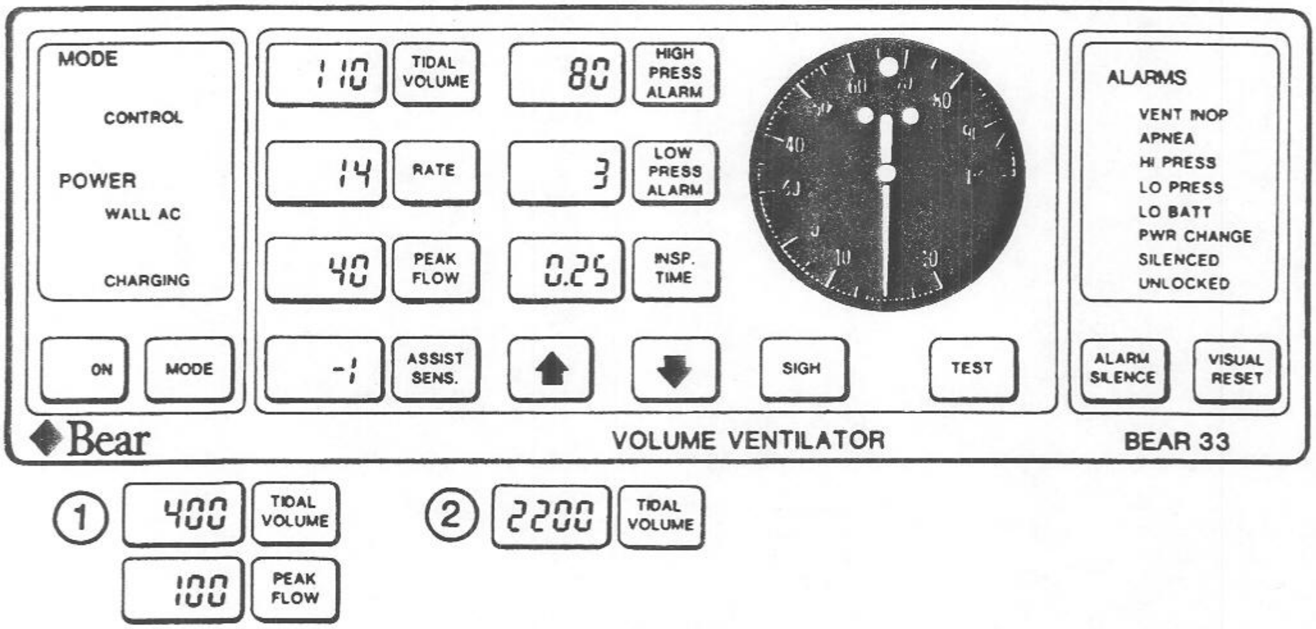

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
110
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
80
HIGH PRESS ALARM
3
LOW PRESS ALARM
0.25
INSP. TIME
SIGH
TEST
ALARMS
VENT INOP
APNEA
HI PRESS
LO PRESS
LO BATT
PWR CHANGE
SILENCED
UNLOCKED
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
①
400
TIDAL VOLUME
100
PEAK FLOW
②
2200
TIDAL VOLUME

Figure 3-11

TIDAL VOLUME DISPLAY FUNCTION TEST

1. UNLOCK the front panel and set all displays to the initial values indicated in Figure 3-11. Allow the ventilator to cycle at least twice to stabilize all functions.
2. Verify that the TIDAL VOLUME LCD display flashes as long as the DOWN button and the TIDAL VOLUME display button are held depressed at the 110 ml setting.

NOTE

Ignore the audible alarm and alarm LED display that may occur during these tests.

3. Increase the TIDAL VOLUME LCD display to 400 ml, then increase the PEAK FLOW LCD display to 100 LPM (Figure 3-11, Item 1).
4. Depress the UP button and the TIDAL VOLUME LCD display button until a reading of 2200 ml is displayed (Figure 3-11, Item 2). Verify that the TIDAL VOLUME LCD display flashes as long as these buttons are held depressed at the 2200 ml setting.
5. Check the appropriate block on the OVP checklist.

DISPLAY SETTINGS FOR RATE TEST

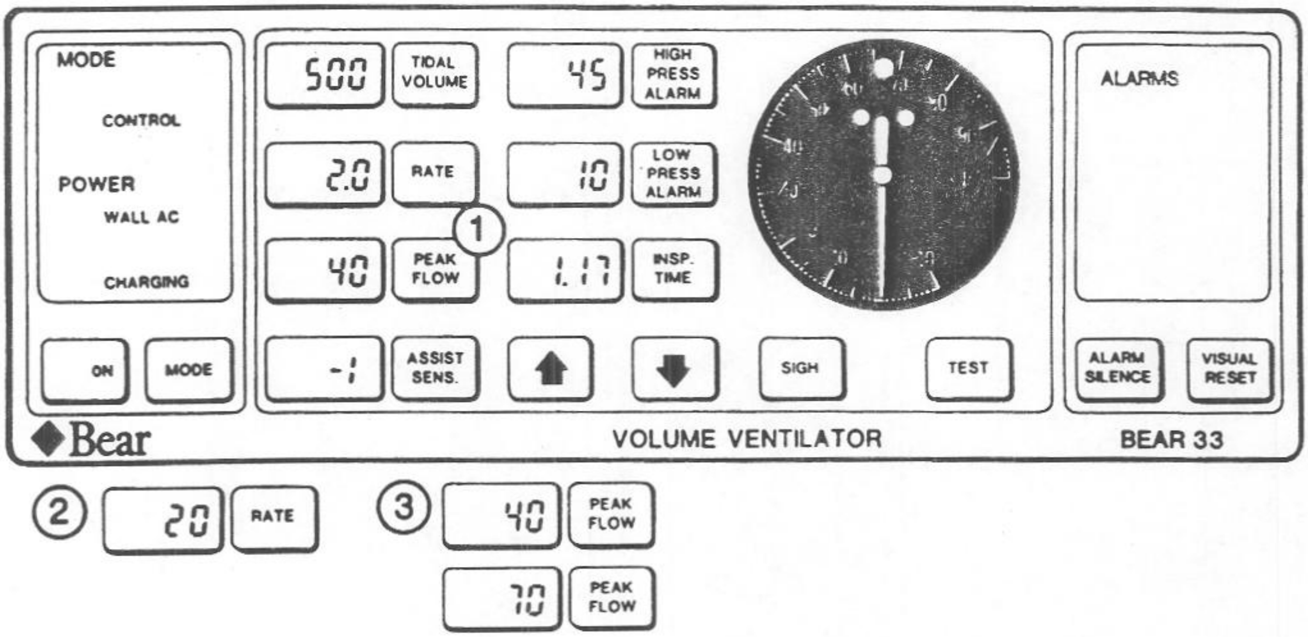

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
2.0
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
①
②
20
RATE
③
40
PEAK FLOW
70
PEAK FLOW

Figure 3-12

RATE TEST

1. UNLOCK the front panel and set all displays to the initial values indicated in Figure 3-12. Allow the ventilator to cycle at least twice to stabilize all functions.
2. Verify that the RATE LCD display flashes as long as the DOWN button and the RATE LCD display button are held depressed at the 2 BPM setting (Figure 3-12, Item 1).

NOTE

Ignore the audible alarm and APNEA LED display that may occur during these tests.

3. Use the stopwatch to time a one-minute period and count the number of delivered breaths during that period. The count must be 2 BPM ±1 BPM.
4. Increase the setting of the RATE LCD display to 20 BPM (Figure 3-12, Item 2). Again, time a one-minute period and count the number of delivered breaths. The count must be 20 BPM ±1 BPM.
5. Increase the setting of the PEAK FLOW LCD display to 70, then increase the setting of the RATE LCD display to 40 BPM (Figure 3-12, Item 3). The number of delivered breaths in one minute must be 40 BPM ±2 BPM.
6. Verify that the RATE LCD display flashes as long as the UP button and the RATE display button are held depressed at the 40 BPM setting.
7. Check the appropriate block on the OVP checklist.

DISPLAY SETTINGS FOR PEAK FLOW DISPLAY TEST

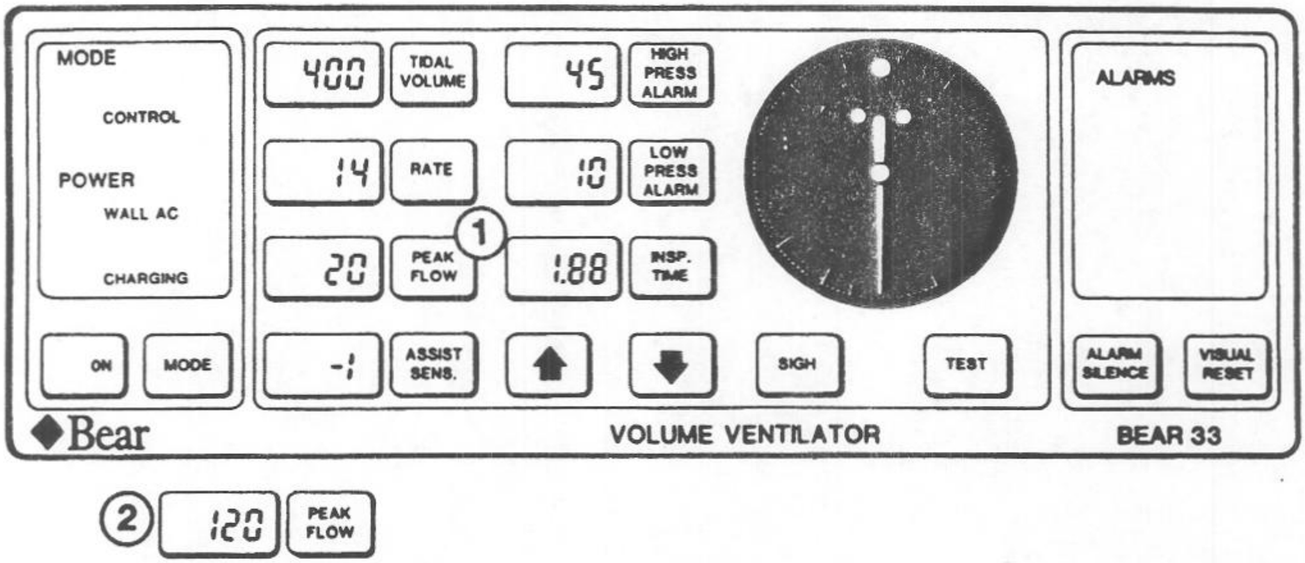

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
400
TIDAL VOLUME
14
RATE
20
PEAK FLOW
-1
ASSIST SENS.
1
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.88
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
2
120
PEAK FLOW

Figure 3-13

PEAK FLOW DISPLAY FUNCTION TEST

1. UNLOCK the front panel and set all displays to the initial values indicated in Figure 3-13. Allow the ventilator to cycle at least twice to stabilize all functions.
2. With the panel unlocked, verify that the PEAK FLOW LCD display continues to flash as long as the DOWN button and the PEAK FLOW display button are held depressed at the 20 LPM setting (Figure 3-13, Item 1).

NOTE

Ignore the audible and visual alarms that may occur during these tests.

3. Change the PEAK FLOW LCD display to 120 LPM (Figure 3-13, Item 2). Verify that the display continues to flash as long as the UP button and the PEAK FLOW display button are held depressed at the 120 LPM setting.
4. Check the appropriate block on the OVP checklist.

DISPLAY SETTINGS FOR ASSIST SENSITIVITY DISPLAY FUNCTION TEST

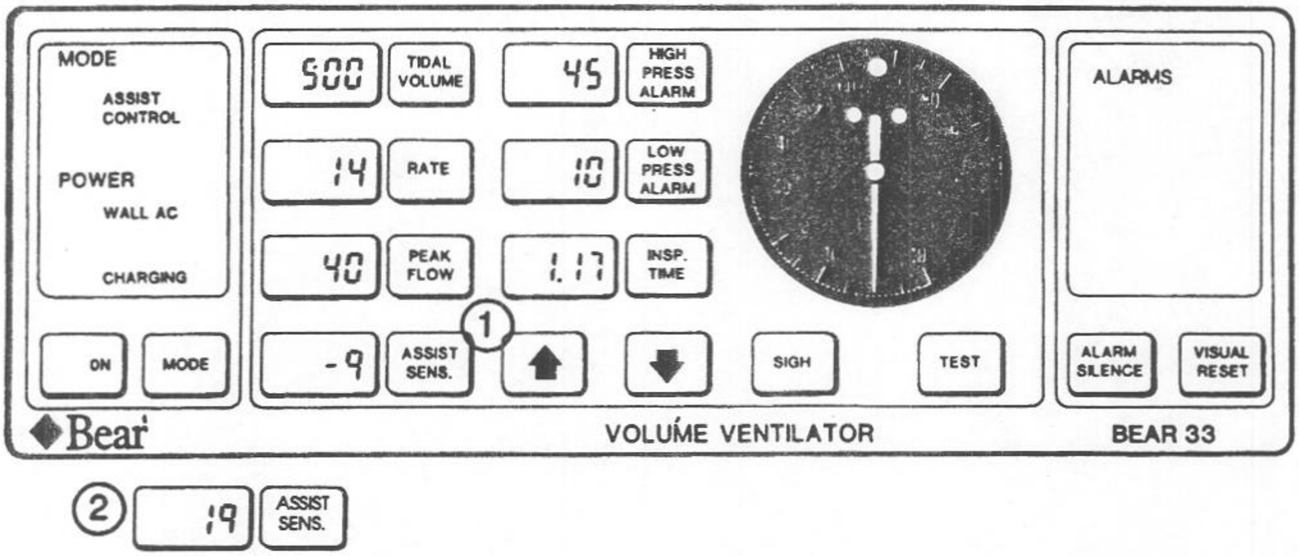

MODE
ASSIST CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-9
ASSIST SENS.
1
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
2
19
ASSIST SENS.

Figure 3-14

ASSIST SENSITIVITY DISPLAY FUNCTION TEST

1. UNLOCK the front panel and set all displays to the initial values indicated in Figure 3-14. Allow the ventilator to cycle at least twice to stabilize all functions.
2. With the panel unlocked, verify that the ASSIST SENS. LCD display continues to flash as long as the DOWN button and the ASSIST SENS. display button are held depressed at the -9 cmH$_2$O setting (Figure 3-13, Item 1).
3. Change the ASSIST SENS. LCD display to 19 cmH$_2$O (Figure 3-13, Item 2). Verify that the display continues to flash as long as the UP button and the ASSIST SENS. display button are held depressed at the 19 cmH$_2$O setting.
4. Check the appropriate block on the OVP checklist.

55

DISPLAY SETTINGS FOR PROXIMAL AIRWAY PRESSURE GAUGE TEST

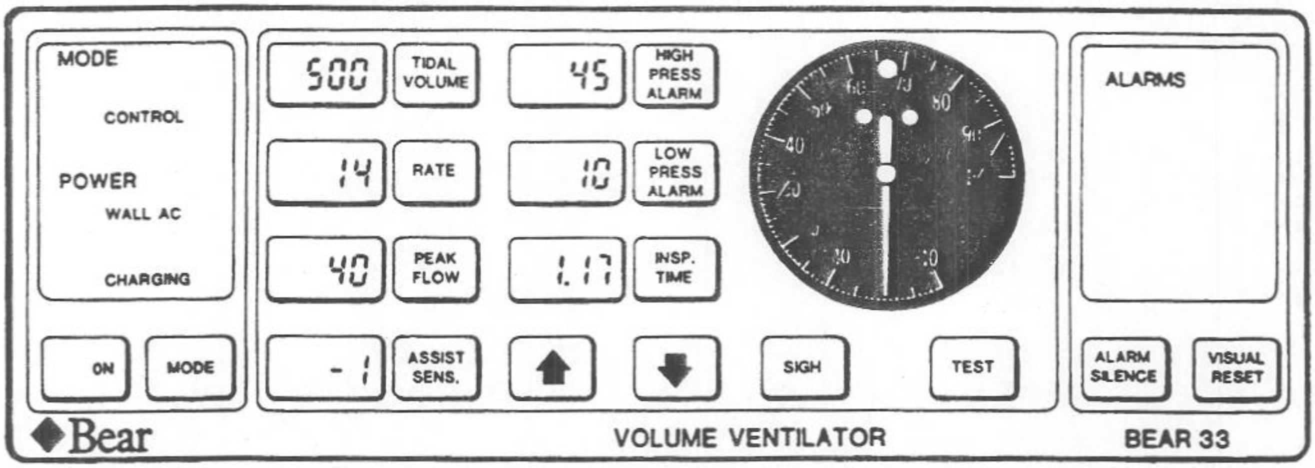

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
- 1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-15A

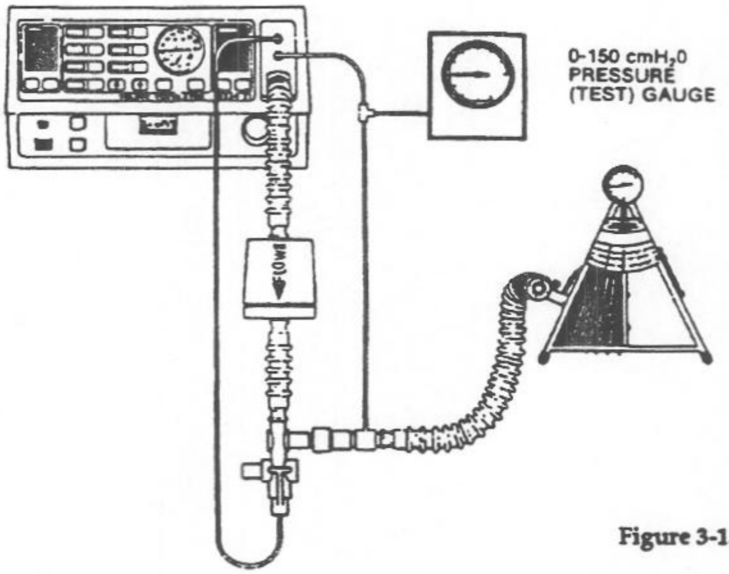

0-150 cmH₂O
PRESSURE
(TEST) GAUGE
FLOW

Figure 3-15B

PROXIMAL AIRWAY PRESSURE GAUGE TEST

1. Connect a 0-150 cmH2O Pressure Test gauge into the PROXIMAL PRESSURE SENSING LINE as indicated in Figure 3-15B above.
2. UNLOCK the front panel and set all displays to STANDARD SETTINGS (Figure 3-15A). Allow the ventilator to cycle at least twice to stabilize all functions.
3. Verify that the pointers on the PROXIMAL AIRWAY PRESSURE GAUGE and the Test Gauge return to zero during the exhalation phase.
4. Verify that the peak reading on the PROXIMAL AIRWAY PRESSURE GAUGE is within ±3 cmH2O of the peak reading on the Test Gauge.
5. Check the appropriate block on the OVP checklist.

STANDARD DISPLAY SETTINGS FOR TESTS

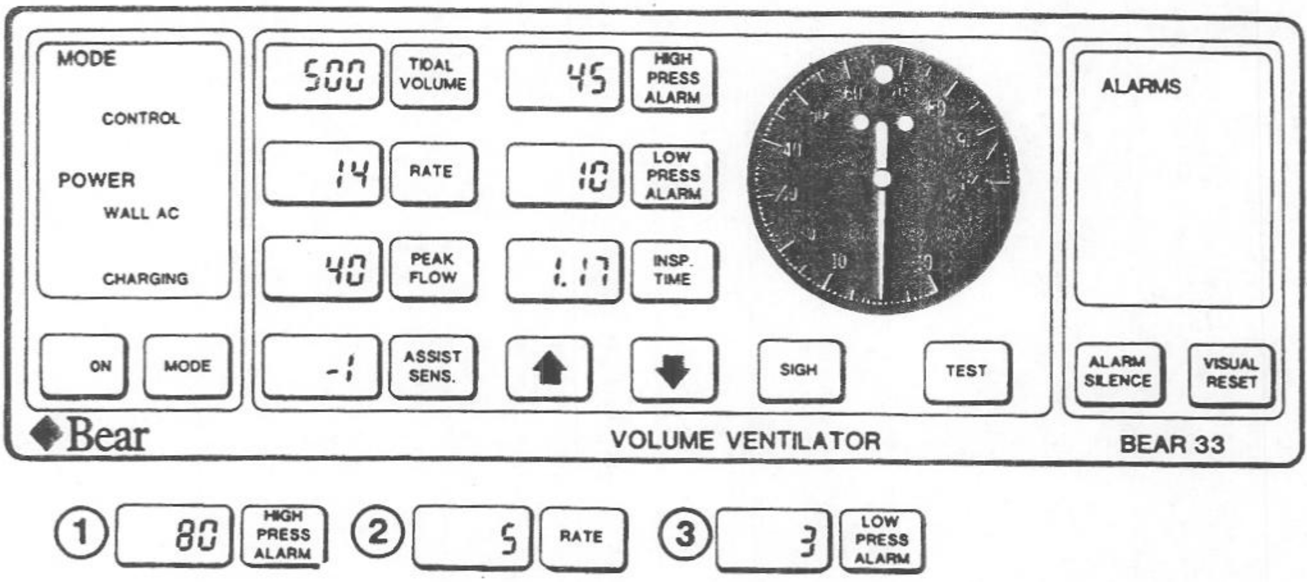

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
①
80
HIGH PRESS ALARM
②
5
RATE
③
3
LOW PRESS ALARM

Figure 3-16

HIGH PRESS ALARM AND APNEA ALARM

A. Operation Below 80 cmH_2O

1. UNLOCK the front panel and set all displays to STANDARD SETTINGS (Figure 3-16). Allow the ventilator to cycle at least twice to stabilize all functions.
2. Carefully observe the peak pressure indicated on the PROXIMAL AIRWAY PRESSURE gauge. Reduce the HIGH PRESS ALARM LCD setting to a value 5 cmH_2O less than the peak pressure reading.
3. Verify that after the first positive pressure breath which exceeds the HIGH PRESS ALARM setting:
   a. The HI PRESS alarm display starts flashing,
   b. Volume delivery is terminated and the PROXIMAL AIRWAY PRESSURE GAUGE falls back to zero,
   c. The audible alarm does not sound.
4. Verify that, after the second positive pressure breath which exceeds the HIGH PRESS ALARM setting:
   a. The audible alarm sounds
   b. Volume delivery is terminated and the PROXIMAL AIRWAY PRESSURE GAUGE falls back to zero
   c. The HI PRESS alarm display continues flashing.
5. Increase the HIGH PRESS ALARM LCD setting to a value 5 cmH_2O greater than the peak pressure reading noted in step 2.
6. Verify that:
   a. The audible alarm stops,
   b. The HI PRESS alarm display continues flashing until the VISUAL RESET button is depressed.

B. Operation Above 80 cmH_2O

1. UNLOCK the front panel and set all displays to STANDARD SETTINGS except set the HIGH PRESS ALARM LCD display to 80 cmH_2O (Figure 3-16, Item 1). Allow the ventilator to cycle at least twice to stabilize all functions.
2. Disconnect the flextube from the test lung and occlude the end of the tube.
3. Verify that, after the first positive pressure breath delivered with the tube occluded:
   a. The HI PRESS alarm display starts flashing,
   b. The audible alarm sounds,
   c. Volume delivery is terminated and the PROXIMAL AIRWAY PRESSURE GAUGE falls back to zero

C. Operation Under Prolonged Inspiratory Pressure

1. Reconnect the standard OVP test circuit and return all ventilator displays to STANDARD SETTINGS except set the RATE LCD display to 5 BPM (Figure 3-16, Item 2). Allow the ventilator to cycle at least twice to stabilize all functions.
2. Immediately following a delivered breath, occlude the patient manifold exhalation port by connecting a one-way check valve in reverse.

3. Verify that, at the first positive pressure breath following occlusion of the port which exceeds the HIGH PRESS alarm setting:
   a. The HI PRESS alarm display starts flashing,
   b. Volume delivery is terminated.
4. Start the stopwatch immediately when the HI PRESS alarm display turns on and verify that:
   a. After approximately three seconds the audible alarm sounds,
   b. In approximately 20 seconds, the APNEA alarm display turns on.
5. Remove the occluding valve from the patient manifold and turn the ventilator power OFF, then back ON. Allow the ventilator to cycle at least twice to stabilize all functions.
6. Again occlude the patient manifold exhalation port with the one-way check valve and wait until the APNEA alarm display turns on. Remove the occluding check valve from the manifold and verify that:
   a. The audible alarm STOPS,
   b. Normal cycling resumes and the APNEA alarm display is turned off by depressing the VISUAL RESET button.
7. Check the HIGH PRESSURE ALARM and APNEA blocks on the OVP checklist.

LOW PRESS ALARM AND PATIENT DISCONNECT

1. UNLOCK the front panel and set all displays to STANDARD SETTINGS except set the LOW PRESS ALARM LCD display to 3 cmH$_2$O (Figure 3-16, Item 3). Allow the ventilator to cycle at least twice to stabilize all functions.
2. Disconnect the flextube from the test lung.
3. Verify that, on the first positive pressure breath following the flextube disconnection:
   a. The LO PRESS display alarm starts flashing,
   b. The audible alarm does not sound.
4. Verify that, on the second positive pressure breath delivered:
   a. The audible alarm sounds,
   b. The LO PRESS display alarm continues flashing.
5. Reconnect the test lung and verify that:
   a. The audible alarm stops,
   b. The LO PRESS display alarm is turned off by depressing the VISUAL RESET button.
3. Check the appropriate blocks on the OVP checklist for LOW PRESSURE ALARM and PATIENT DISCONNECT.

STANDARD DISPLAY SETTINGS FOR DELIVERED VOLUME TEST

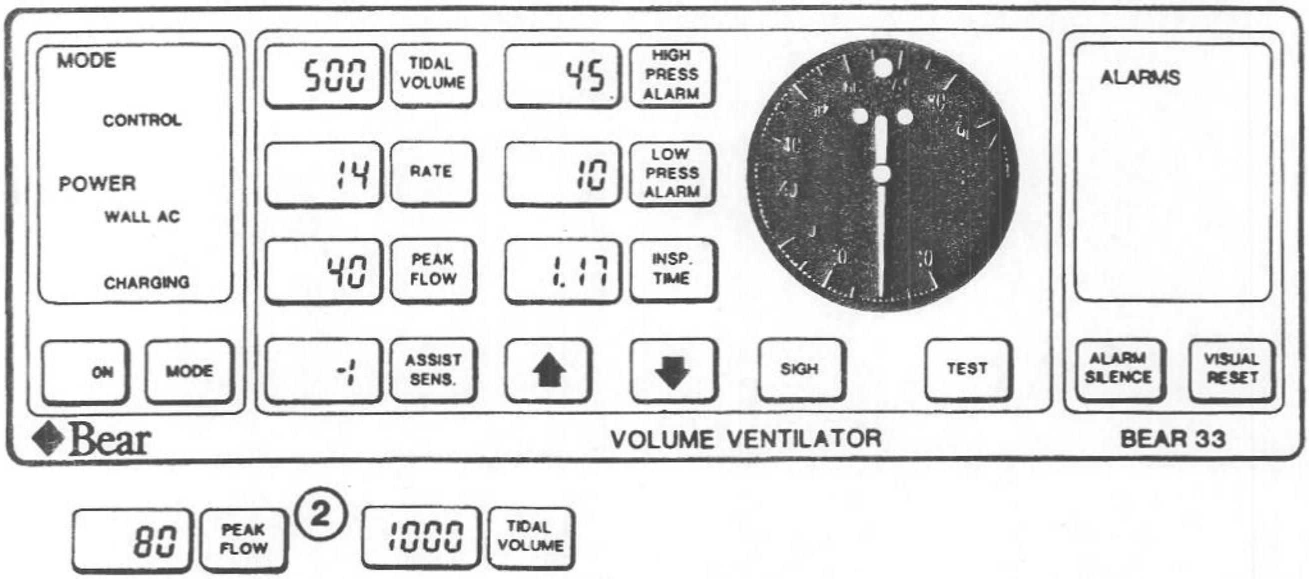

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
500
TIDAL VOLUME
14
RATE
40
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.17
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33
80
PEAK FLOW
②
1000
TIDAL VOLUME

Figure 3-17A

DELIVERED VOLUME TEST

1. Reconnect the test circuit as in Figure 3-17B, with the spirometer replacing the test lung.
2. UNLOCK the front panel and adjust all displays to STANDARD SETTINGS (Figure 3-17A). Allow the ventilator to cycle at least twice to stabilize all functions.
3. Disconnect the 3/4" hose from the spirometer, zero the spirometer, and reconnect the hose to the spirometer during an exhalation phase of the ventilator.
4. Allow the ventilator to deliver 10 breaths and disconnect the spirometer hose before the eleventh breath begins. Verify that the spirometer reads 5.0L ±0.25L.
5. Reconnect the spirometer hose. Increase the PEAK FLOW LCD display to 80 LPM and the TIDAL VOLUME LCD display to 1000 ml (Figure 3-17A, Item 2).
6. Disconnect the spirometer hose, zero the spirometer, and reconnect the hose during an exhalation phase of the ventilator.
7. Allow the ventilator to deliver two breaths and disconnect the spirometer hose before the third breath begins. Verify that the spirometer reads 2.0L ±0.1L.
8. Check the appropriate block on the OVP checklist.

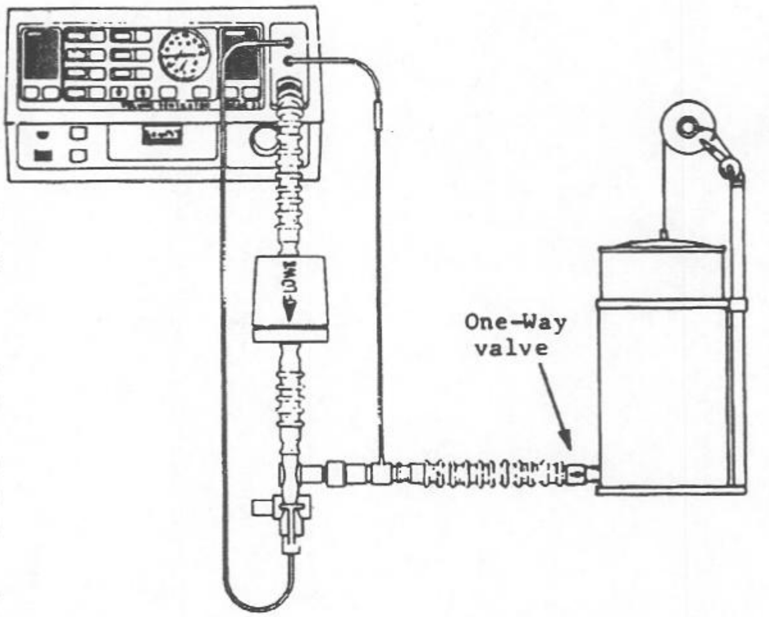

FLOW
One-Way valve

Figure 3-17B

DISPLAY SETTINGS FOR OVERPRESSURE RELIEF VALVE TEST

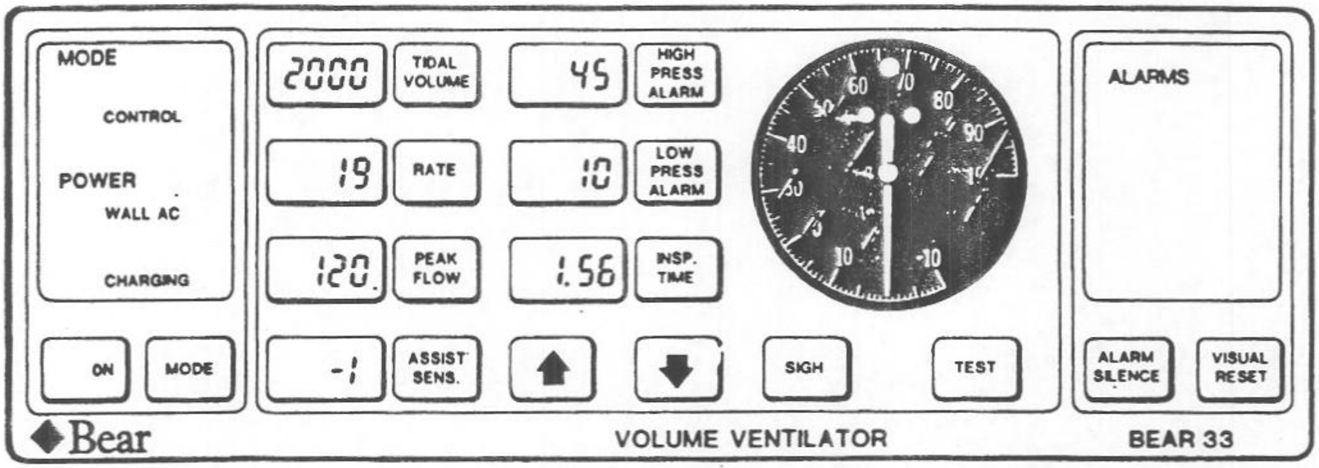

MODE
CONTROL
POWER
WALL AC
CHARGING
ON
MODE
2000
TIDAL VOLUME
19
RATE
120
PEAK FLOW
-1
ASSIST SENS.
45
HIGH PRESS ALARM
10
LOW PRESS ALARM
1.56
INSP. TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 3-18A

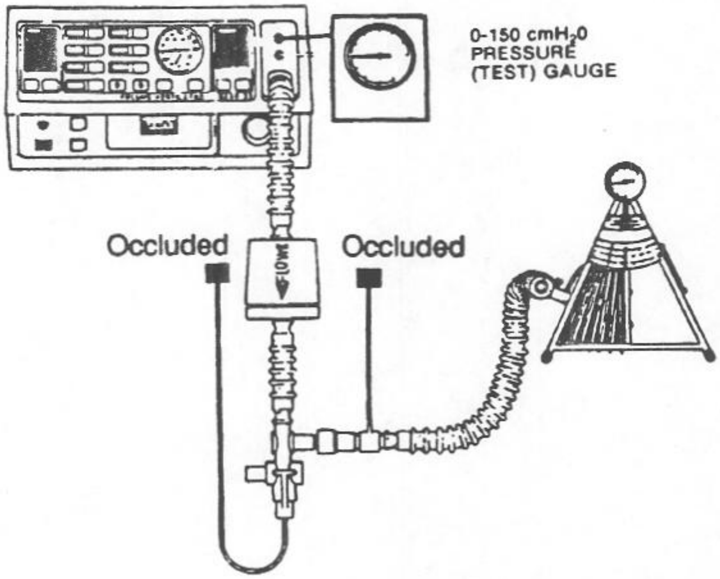

0-150 cmH$_2$0
PRESSURE
(TEST) GAUGE
Occluded
Occluded
FLOW

Figure 3-18B

OVERPRESSURE RELIEF VALVE TEST

1. Reconnect the test circuit as in Figure 3-18B. The Manley Test Lung is set at C10/R5.
2. Turn ventilator power ON and set all displays to the initial values in Figure 3-18A.

WARNING

IF THE TEST GAUGE READING APPROACHES 150 cmH$_2$O, IMMEDIATELY TURN UNIT OFF TO AVOID EXCESSIVE PRESSURE, CAUSING DAMAGE TO THE UNIT OR THE OPERATOR.

3. Verify that pressure indicated on the test gauge does not exceed 125 cmH$_2$O.

NOTE

Ignore the LO PRESS LED and audible alarm.

4. If system pressure does not exceed 125 cmH$_2$O, repeat step three twice.
5. Check the appropriate block on the OVP checklist.

BEAR® 33 VOLUME VENTILATOR
OPERATIONAL VERIFICATION CHECK LIST

This checklist is for use during the BEAR® 33 Operational Verification

BEAR® 33 Serial Number____________ Hour meter reading____________ Today's date ______________

Service Location ______________________ Service organization __________________________

Address ______________________ Address __________________________

City, State, Zip ______________________ City, State, Zip __________________________

Contact ______________________ Service Person __________________________

Phone (___) ______________________ Phone (___) __________________________

VERIFICATION STEPS

STEP	OPERATION	TEST RESULTS	ACCEPT	UNACCEPT
General Inspection	Clean and check	As specified	☐	☐
Display & Alarm Test	Perform test	As specified	☐	☐
Power Up	Verify	As specified	☐	☐
System Leak Test				
Proximal Airway Pressure	Perform Test	As specified	☐	☐
Baseline Pressure	Perform Test	As specified	☐	☐
CONTROL MODE	Verify	As specified	☐	☐
ASSIST CONTROL MODE	Verify	As specified	☐	☐
SIMV MODE	Verify	As specified	☐	☐
SIGH Function	Verify	As specified	☐	☐
Tidal Volume Display	Verify	As specified	☐	☐
Rate	Verify	As specified	☐	☐
Peak Flow Display	Verify	As specified	☐	☐
Assist Sensitivity Display	Verify	As specified	☐	☐
Proximal Airway Pressure Gauge	Verify	As specified	☐	☐
High Pressure Alarm	Verify	As specified	☐	☐
Apnea	Verify	As specified	☐	☐

Low Pressure.Alarm	Verify	As specified	☐	☐
Patient Disconnect	Verify	As specified	☐	☐
STEP	OPERATION	TEST RESULTS	ACCEPT	UNACCEPT
Delivered Volume	Verify	As specified	☐	☐
LOW EXH. VOL Alarm	Check alarm	As specified	☐	☐
Overpressure Relief Valve	Verify	As specified	☐	☐

WARNING

DO NOT RELEASE THE VENTILATOR FOR USE IF IT DOES NOT PASS ALL OF THE VERIFICATION PROCEDURES SPECIFIED IN THE CHECKLIST. TO DO SO COULD RESULT IN PERSONAL INJURY OR PROPERTY DAMAGE. REFER THE VENTILATOR TO A BEAR MEDICAL SYSTEMS SERVICE TECHNICIAN, A BEAR MEDICAL SYSTEMS AUTHORIZED SERVICING DEALER, OR A BEAR MEDICAL SYSTEMS TRAINED HOSPITAL SERVICE TECHNICIAN FOR APPROPRIATE REPAIR AND/OR CALIBRATION.

Signature________________________________

PROCEDURE COMPLETE

SECTION 4

BEAR® 33 VOLUME VENTILATOR PARTIAL DISASSEMBLY

Cover Removal

This procedure is for gaining access to the interior of the ventilator for the purpose of maintenance or repair.

Procedure

1. Turn off the ventilator and disconnect it from AC power and pressurized gas sources.
2. Position the ventilator on its rear panel to access and remove the two cover securing screws indicated by "A" in Figure 4-1.
3. Remove patient outlet fitting indicated by "B" in Figure 4-1.
4. Remove four phillips-head screws and washers located near each corner on the bottom of the ventilator.
5. Return the ventilator to its normal operating position and remove the three machine screws located on the upper rear panel. These screws fit into a flange on the rear of the cover.
6. Lift the cover slightly, then tilt the rear of the cover and slide it forward so that as it is lifted, it clears the Patient Outlet Panel.
7. Lift cover straight up and to the right.

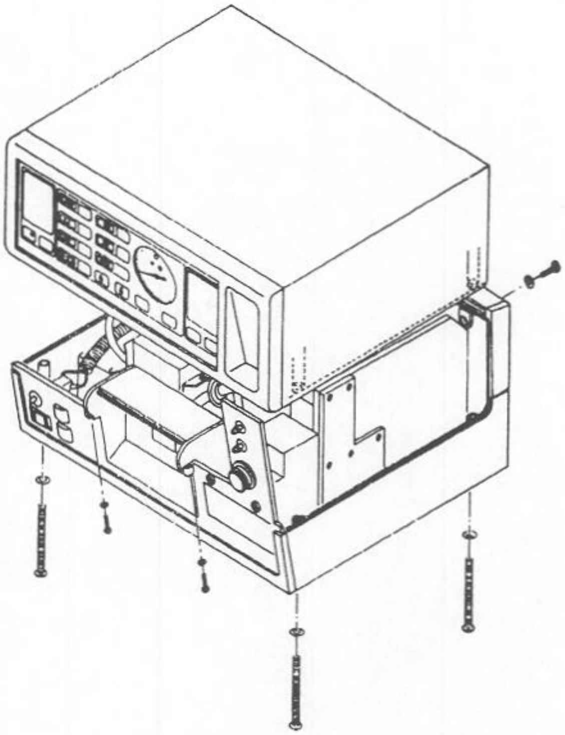


Figure 4-1
COVER REMOVAL

SECTION 5
BEAR® 33 VOLUME VENTILATOR CALIBRATION AND VERIFICATION

Introduction

The information in this section is intended for use by a Bear Medical Systems factory-trained service technician. Before removing cover and/or attached assemblies to perform verification tests or calibration adjustments, refer to the BEAR® 33 Volume Ventilator Clinical Instruction Manual and to Sections 1, 2, and 3 of this Manual to verify that the ventilator is being properly utilized.

Read all warnings and cautions before attempting any of the verification or calibration procedures.

These procedures must be performed when any part or assembly has been removed or replaced. A majority of the procedures in this section require only verification of proper operation. When calibration adjustment is required, the verification measurements must again be performed after the adjustment is complete. If any verification measurements are out of tolerance, and if calibration is either not possible or ineffective, refer to Section 7 of this Manual to determine the defective part or assembly. Sections 4, 8, and 10 of this Manual will assist in determining and replacing defective parts.

General Procedure

The procedure detailed in this section are to ensure operation of the ventilator within the published parameters. To meet that objective, the following steps, in the order listed, are necessary:

1. Perform the OVP (Section 3).
2. Complete the verification/calibration procedures (this section).
3. Perform the ventilator stress test (this section), including a "burn in" period.
4. Repeat the OVP.

The OVP represents an essential part of the complete verification of proper operation. Those operating conditions and parameters that are verified by the OVP are not repeated in this section. The stress test described at the end of this section, in conjunction with the required burn-in period, serve to assure that no malfunctions were incurred or induced as a result of the tests performed. They also verify that any corrective action taken has, in fact, resolved the original malfunction. By performing the OVP after the burn-in period, the technician is assured that the unit has been returned to serviceable condition.

Equipment and Techniques

Each procedure in this section includes a list of the specific equipment required to perform that procedure taken from the following complete list. Standard tools and accessories (pliers, screwdrivers, wrenches, tubing, tees, connectors, etc.) are assumed to be available and are not listed.

Table 5-1
Equipment Required

Item	Recommended Supplier
Multimeter, digital, 3 1/2 digit	Tektronix Model DM 502 or equivalent
Power Supply, DC, 0 to 15 VDC, 3 A. minimum	
Source, Variable AC, 0 to 150 VAC	
Tester, Current Leakage and Ground Resistance	Biotek Model 150M with Model 11 Adapter or equivalent
Calibration Analyzer	Timeter Series RT-200 or equivalent with pressure and flow module
Stopwatch	General Purpose
Patient Circuit Kit	Bear P/N 50000-08020
Clinical Instruction Manual	Bear P/N 50000-10133
Maintenance Manual	Bear P/N 50000-12066
Operational Verification Procedure	Bear P/N 50000-12075
Filter, Mainflow Bacteria	Bear P/N 51000-01054
Extension Kit	Bear P/N 50000-03119

64

The following general techniques and practice are assumed:

a. All electrical measurements, unless otherwise stated, are assumed to be measured from the specified test point to ground.

b. Unless otherwise stated, all values are nominal. Variations in test equipment calibration must be taken into consideration. Test equipment must be periodically calibrated to assure conformance to the manufacturer's specifications.

c. The panel UNLOCK button must be depressed before any control settings or functions are changed.

d. Figure 5-1 illustrates the DEFAULT SETTINGS. Default settings and Standard settings are identical except when CONTROL Mode is used instead of ASSIST CONTROL Mode.

e. The Standard Test Circuit (Figure 5-2) is used or all Verification/Calibration tests unless otherwise stated as part of a particular test procedure.

f. Unless otherwise stated, the audible alarm may be silenced during verification/calibration procedures. The alarm will remain silenced for approximately 60 seconds when the ALARM SILENCE button is depressed once.

g. Proximal Pressure gauge readings may be different when the gauge is upside-down versus right-side-up. For that reason, the gauge readings are verified before the unit cover is removed. Once the cover is removed, the gauge will be lying upside-down. If readings in that position are suspect, return the cover to the right-side-up position before continuing the test.

h. The general test sequence should be:
   1. Verify proximal pressure gauge.
   2. Disassemble unit and inspect visually.
   3. Verify electrical tests.
   4. Verify default settings.
   5. Verify power supply values and alarms
   6. Verify control operations and display value.
   7. Verify and calibrate Monitor ADC reference voltage source (if necessary).
   8. Verify and calibrate pressure transducer (if necessary).

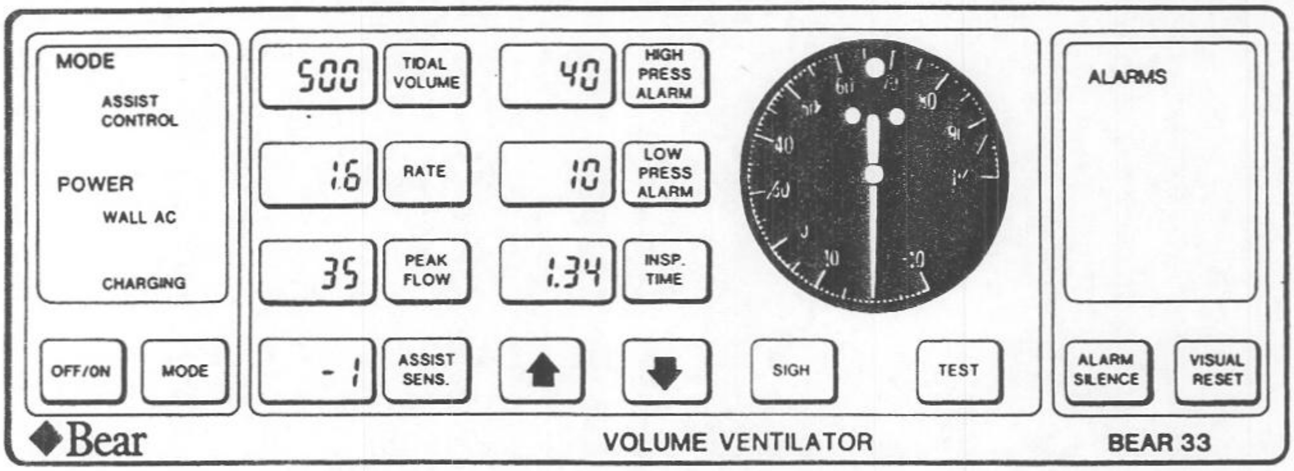

MODE
ASSIST CONTROL
POWER
WALL AC
CHARGING
500
TIDAL VOLUME
40
HIGH PRESS ALARM
16
RATE
10
LOW PRESS ALARM
35
PEAK FLOW
1.34
INSP. TIME
ALARMS
OFF/ON
MODE
-1
ASSIST SENS.
SIGH
TEST
ALARM SILENCE
VISUAL RESET
Bear
VOLUME VENTILATOR
BEAR 33

Figure 5-1
DEFAULT SETTINGS

Proximal Pressure Gauge Verification

NOTE

This procedure is performed prior to disassembling the unit.

Perform this procedure to verify the accuracy of the Proximal Pressure Gauge.

Equipment:
Regulator, 0-2 psi air
Valve, in-line shut-off
Calibration Analyzer, Timeter Series RT-200 or equivalent.

1. With the ventilator power switch OFF, connect the test circuit as shown in Figure 5-3.
2. Close the in-line shutoff valve and vent the pressure line to atmosphere by disconnecting the tubing at the ventilator PROX. TEE port.
3. Follow the RT-200 operating instructions to select the 250 cmH2O gas pressure range and zero the analyzer.
4. Observe the PROXIMAL PRESSURE GAUGE and verify that the needle reads 0 ±0.5 cmH2O.
5. Connect the tubing to the ventilator and, with the 0-2 psi regulator turned off (or very low), carefully open the in-line valve. Adjust the regulator for a reading of 15 cmH2O on the RT-200 and verify that the gauge reads 15 ±1.0 cmH2O.

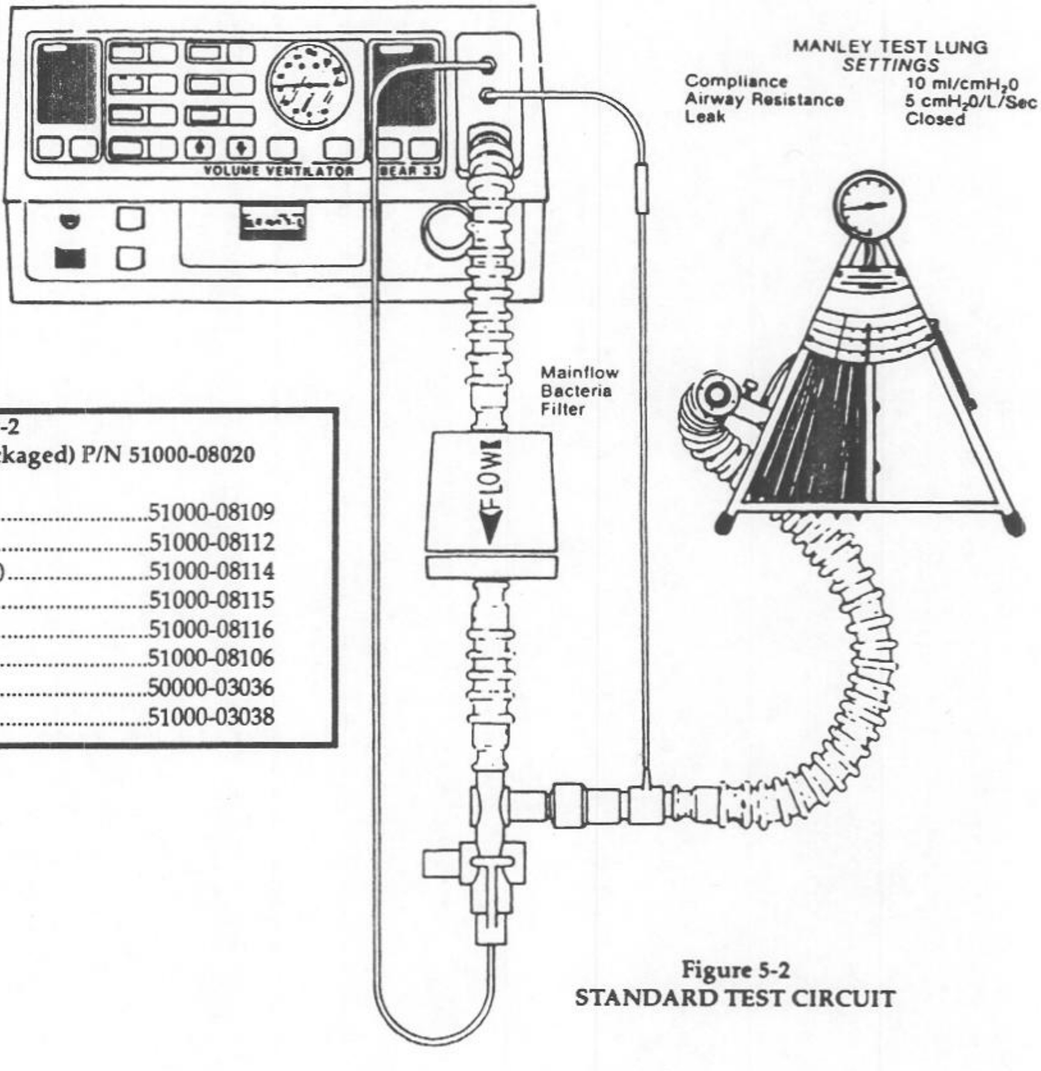

MANLEY TEST LUNG
SETTINGS
Compliance 10 ml/cmH$_2$0
Airway Resistance 5 cmH$_2$0/L/Sec
Leak Closed
VOLUME VENTILATOR
BEAR 33
Mainflow Bacteria Filter
FLOW

Figure 5-2
STANDARD TEST CIRCUIT

Table 5-2
PATIENT CIRCUIT KIT (packaged) P/N 51000-08020

Patient Tubing (5 ft)	51000-08109
Patient Tubing (18")	51000-08112
Flextube, Tracheostomy (packaged)	51000-08114
Manifold, Patient (packaged)	51000-08115
Tee, Proximal Pressure (packaged)	51000-08116
Clip, Tubing (10 pack)	51000-08106
Tubing, PVC 3/16" ID, 8 ft	50000-03036
Tubing, PVC 1/8" ID, 8 ft	51000-03038

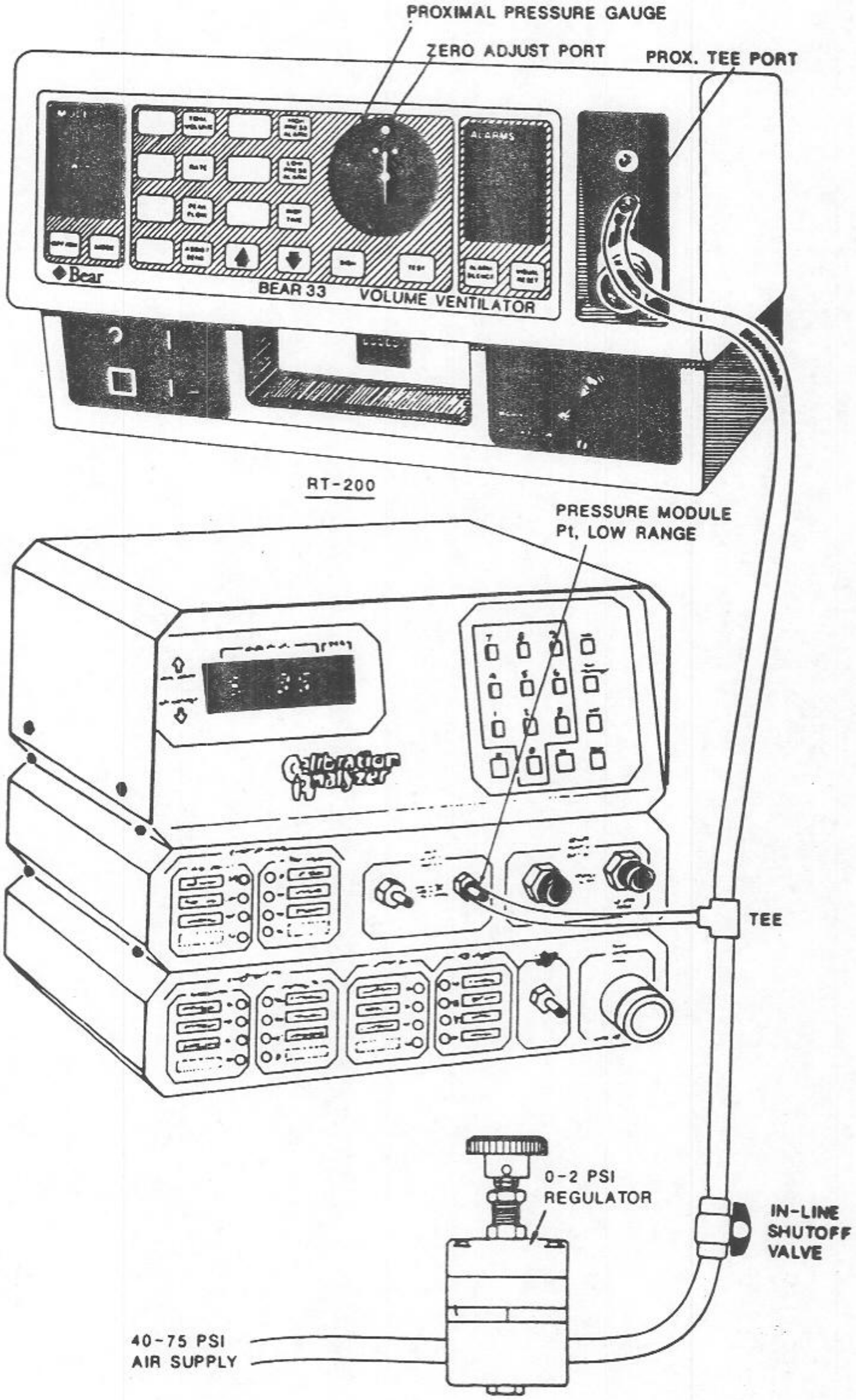

PROXIMAL PRESSURE GAUGE
ZERO ADJUST PORT
PROX. TEE PORT
Bear
BEAR 33 VOLUME VENTILATOR
RT-200
PRESSURE MODULE
Pt, LOW RANGE
TEE
0-2 PSI
REGULATOR
IN-LINE
SHUTOFF
VALVE
40-75 PSI
AIR SUPPLY

Figure 5-3
PRESSURE TEST CIRCUIT

67

Table 5-3
Pressure Gauge Specifications

Static Pressure (cmH_2O)	Gauge Tolerance (cmH_2O)
0 (Ambient)	±0.5
15	±1.0
45	±2.0
75	±3.0

6. Repeat Step 5 for readings of 45 and 75 cmH_2O, and verify gauge accuracy within the tolerances shown in Table 5-3.
7. If the gauge reads consistently high or low by the same amount that the zero adjust was off, it might help to return to Steps 2, 3, and 4 and adjust the gauge to exactly zero. Then repeats Steps 5 and 6.
8. Decrease the regulator output to zero, close the in-line valve, and vent the pressure line to atmosphere as in Step 2. Verify that the gauge reading returns to 0 ±0.5 cmH_2O.

Unit Disassembly and Visual Inspection

Perform this procedure to prepare for further testing, and to inspect the unit for obvious internal problems.

1. Remove the nine screws that secure the cover to the base of the unit. See Section 4 of this manual for the location of the screws.
2. Lift the cover enough to reach underneath it and disconnect the tubing connections at P1 of the pressure transducer and at the tee on the rear of the Proximal Pressure Gauge. Also, unplug J11 from P4 on the Controller PCB. See Figure 5-4 for the locations.
3. Cut the cable tie holding the wire bundle to the case in front of the internal battery (Figure 5-4).
4. Rotate the cover to lay it upside down on the left side of the base.
5. Reconnect the tubing and electrical connections by extending them, using parts from the extension kit.

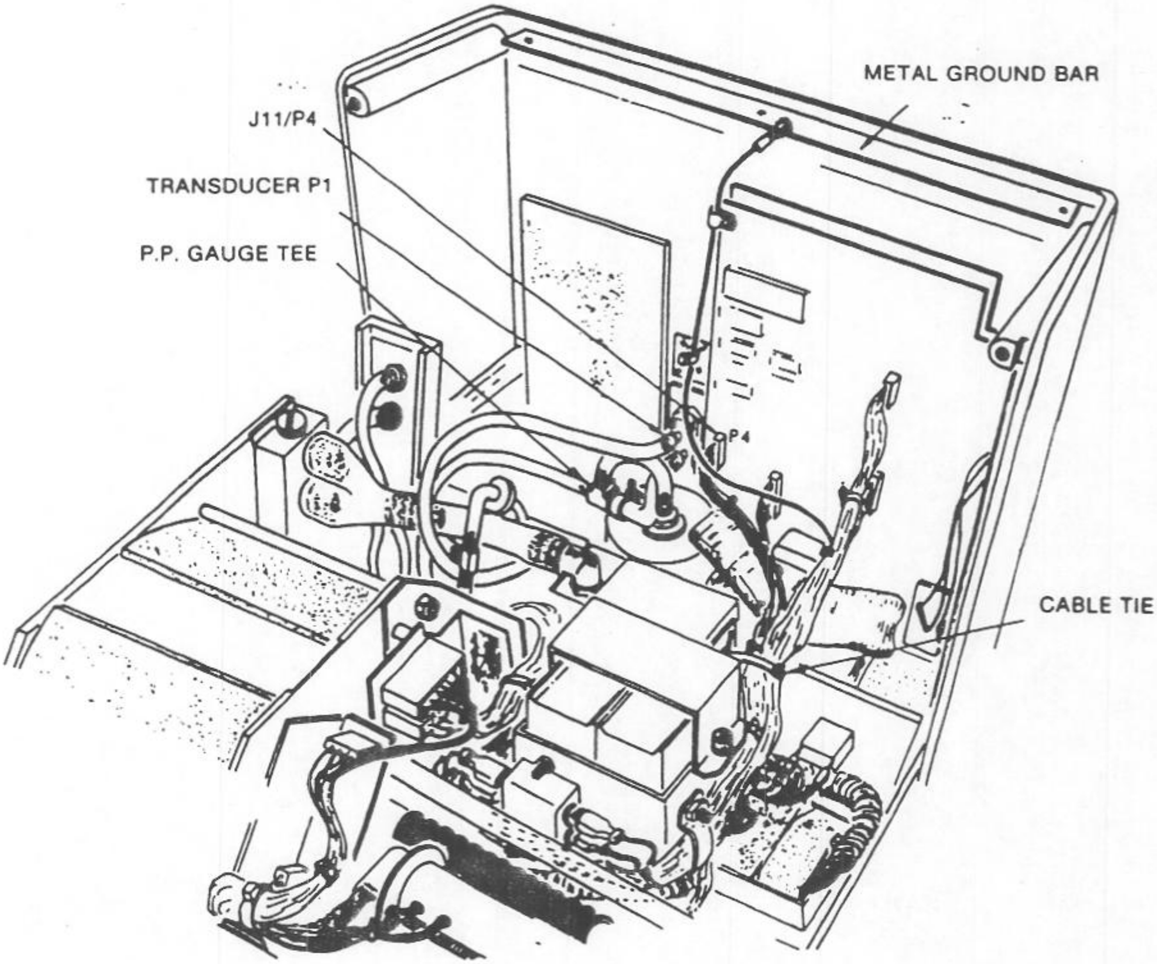


Figure 5-4
TOP, INSIDE VIEW

68

6. Make a complete visual inspection of the unit's interior. Look for any obvious signs that indicate existing or potential problems. Be sure to check the following:
   a. All electrical connectors for proper seating.
   b. All cables and wires for evidence of rubbing, wear, or arcing.
   c. Tubing connections for proper seating
   d. Tubing for evidence of rubbing, wear, or leaks.
   e. Major assemblies and PCBs for mounting security or loose screws/bolts/nuts.

Electrical Tests

Perform this procedure to verify current leakage and ground resistance values (per UL 544).

Specifications:

Current Leakage	30 microamps maximum
Ground Resistance	0.1 ohms maximum at 25 A.

Equipment:

Current Leakage Tester, Biotek Model 150M, or equivalent

Ground Resistance Tester, Biotek Model 150M with Model 11 adapter, or equivalent

1. Current Leakage Test
   a. Plug the AC power connector of the ventilator into the AC outlet of the leakage tester.
   b. Follow the tester manufacturer's instructions and measure the leakage in forward and reverse, both grounded and ungrounded combinations. The display settings are not critical to this test.
   c. Current leakage must not exceed 30 microamps in any combination (UL 544).

2. Ground Resistance Test
   a. Connect one lead of the ground resistance tester to the ground pin of the AC power plug of the ventilator.
   b. Connect the other tester lead to the metal bar at the back of the inside of the ventilator cover (Figure 5-4).
   c. Follow the tester manufacturer's instruction and measure the ground resistance at a current of 25 amperes.
   d. Ground resistance must not exceed 0.1 ohms at 25A (UL 544).

Default Parameters Verification

Perform this procedure to verify that the unit will default to the proper parameters in case of a total loss of power.

1. Make sure the unit power is switched OFF and unplug the unit from the AC power line.
2. Disconnect the leads from the internal battery (Figure 5-5) and unplug the external battery, if connected.
3. Position the ventilator to access the Controller PCB.
4. Remove the four wiring harnesses, and mark for reconnection.
5. Remove the four screws which secure the Controller PCB to the Monitor PCB.
6. Remove the Controller PCB from the Monitor PCB by placing one hand under each corner of the Controller PCB and gently lifting to separate it from the 34-pin connector on the Monitor PCB (Figure 5-6).
7. Silence the audible alarm by connecting a short across the terminals of C10, the 3.3F. Supercap (Figure 5-6). Remove the short when the alarm will remain off.
8. Reinsert the Controller PCB.
9. Connect the Standard Test Circuit shown in Figure 5-2, plug the unit into an appropriate AC power source, and switch the unit to ON.
10. Compare the display readings to Figure 5-1. The MODE LED should read "ASSIST CONTROL," and all LCD display values must be as indicated in Figure 5-1.
11. Switch the unit power to Off and reconnect the internal battery leads.

69

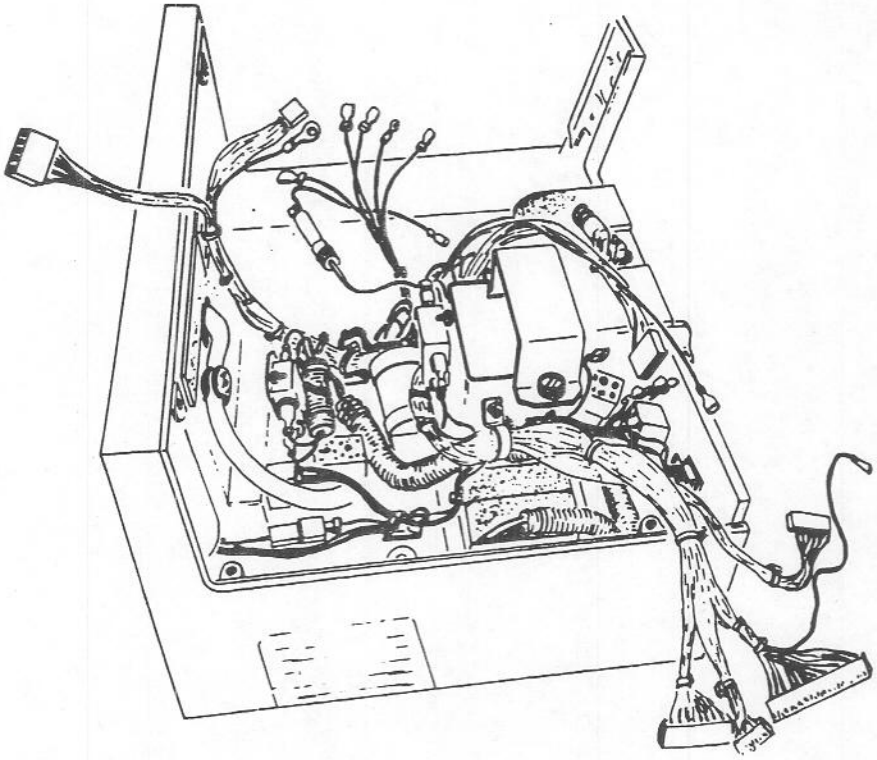


Figure 5-5
TOP VIEW OF OPEN UNIT

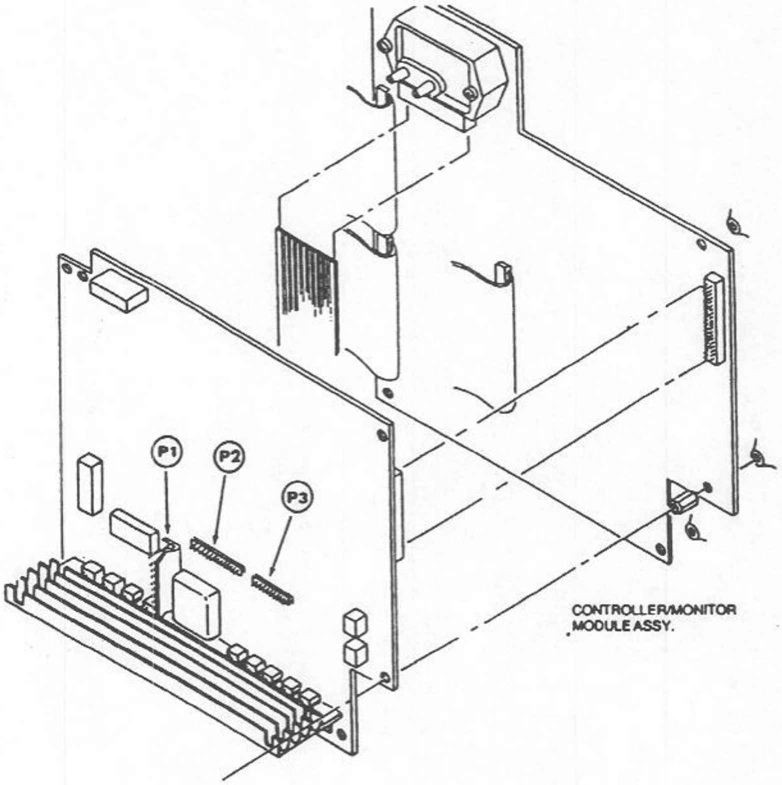

P1
P2
P3
CONTROLLER/MONITOR MODULE ASSY.

Figure 5-6
CONTROLLER/MONITOR PCB ASSEMBLY

Power Supply Verification

Perform this procedure to verify power supply voltages and voltage regulation; to verify proper operation and priority of the power supply monitors and alarms.

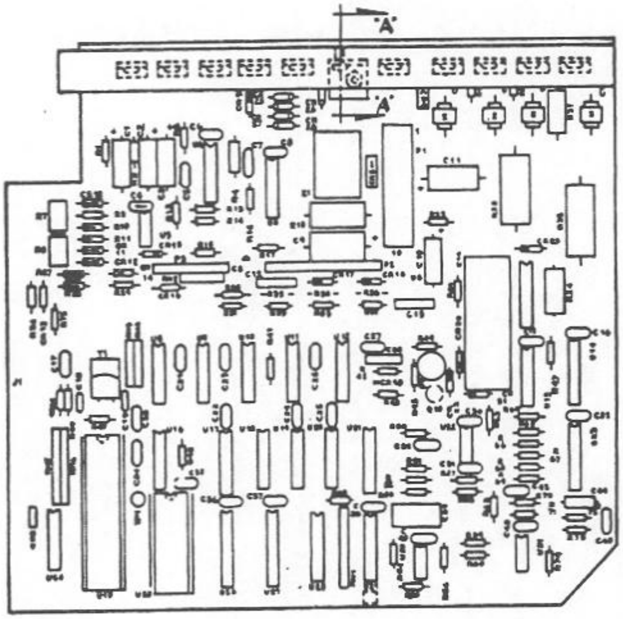
Specifications:
See Tables 5-4, 5-5, 5-6

Equipment:
Digital Multimeter
Variable AC source
Variable DC source

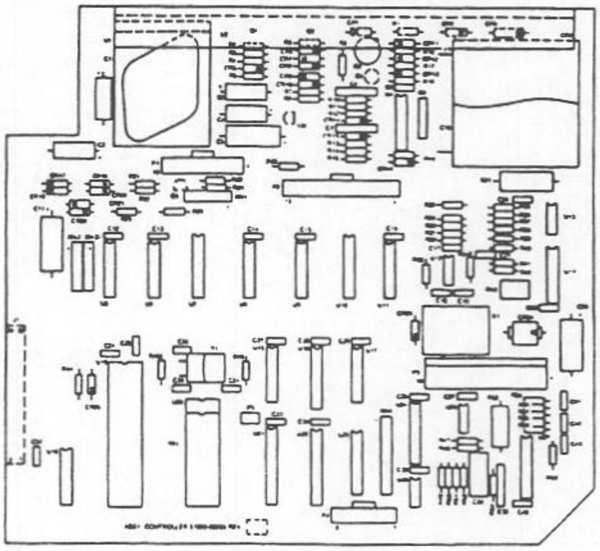
1. Verify nominal power supply values.
   a. Connect the Standard Test Circuit as shown in Figure 5-2. Make sure the internal battery is installed and fully charged.
   b. Turn the ventilator power switch ON and verify that the INT. BATT. meter indicator is in the green area.
   c. Set all controls to Standard Settings, except set the RATE to 3.0 BPM. The POWER LED will indicate INT. BATT.
   d. While the *motor is moving*, measure each of the voltages in Table 5-4 *except* +BUS SW and verify that they are within stated limits. Refer to Figure 5-7 for the location of the test points.
   e. Turn the power switch OFF and connect the unit to a variable AC power source set to the proper nominal rated line voltage
   f. While the *motor is idle*, measure the +BUS SW on the Controller PCB. It must indicate from 19.0 to 23.0 VDC.

See Table 5-5 for an overview of line voltage/frequency combinations and set to the appropriate nominal values.

2. Verify the power supply high and low line regulation:
   a. Adjust the variable AC source to the appropriate HIGH LINE value in table 5-5. Re-measure all voltages in Table 5-4 (all except +BUS SW while the motor is moving) and verify each is within the stated limits.
   b. Re-adjust the variable AC source to the appropriate LOW LINE value in Table 5-5 and repeat the measurements in Table 5-4 (all except +BUS SW while the motor is moving).



Assembly Controller PCB P/N 51000-08069



Assembly Controller PCB P/N 51000-08226

Figure 5-7
TEST POINTS AND ADJUSTMENTS

Table 5-4
Power Supply Voltages Test Point

BUS	PCB	51000-08069	51000-08226	Minimum	Maximum
+5 VDC	Controller	C9+	C5+	4.75v	5.25v
+5 VDC SW	Controller	C3+	C2+	4.75v	5.25v
+BUS SW	Controller	C2+	C1+	19.0v	23.0v
+10 VDC	Controller	C1+	C3+	6.80v	7.50v
+7.15 VDC	Monitor	TP2	TP2	6.80v	7.50v

Table 5-5
AC Line Voltages

Nominal Rated Line Voltage	80% Nominal (LOW LINE VAC)	84% Nominal (VAC)	HIGH LINE (VAC)
100 VAC, 50/60 Hz	80	84	110
120 VAC, 60 Hz	96	100.8	132
220 VAC, 50/60 Hz	176	184.8	242
240 VAC, 50 Hz	192	201.6	264

Table 5-6
Power Supply Priority Alarms, and Monitor Thresholds

		Power LED				Alarm LED			
	Power Source Voltages	Wall AC	EXT BATT	INT BATT	CHARGING	VENT INOP	LO BATT	PWR CHANGE	Audible Alarm
1.	AC-Nominal Ext. DC-12.7v Int DC-Battery, Fully Charged	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF
2.	AC-below 80% Nominal Ext. DC-12.7v Int. DC Battery	OFF	ON	•	OFF	•	•	ON	ON
3a.	AC: 80-84% Nominal Ext. DC-12.7 Int. DC-Battery	ON	OFF	•	ON	•	•	ON	OFF
3b.	Press VISUAL RESET	•	•	•	•	•	•	OFF	•
4a.	AC-Disconnected Ext. DC-12.7v Int. DC-Battery	OFF	ON	•	OFF	•	•	ON	ON
4b.	Press VISUAL RESET	•	•	•	•	•	•	OFF	OFF
5.	AC-Disconnected Ext. DC-10.5v ±0.3v Int. DC-Battery	•	OFF	ON	•	•	•	ON	ON
6a.	AC-Disconnected Ext. DC-12.1v ±0.3v Int. DC-Battery	•	ON	OFF	•	•	•	•ON	OFF
6b.	Press VISUAL RESET	•	•	•	•	•	•	OFF	•
7.	AC-Nominal Ext. DC-12.1v ±0.3v Int. DC-Battery	ON	OFF	•	ON	•	•	ON	OFF
8a.	AC-Below 80% Nominal Ext. DC-Disconnected Int DC-13.8 VDC	OFF	OFF	ON	OFF	OFF	OFF	ON	ON
8b.	Press VISUAL RESET	•	•	•	•	•	•	OFF	OFF
9a.	AC-Disconnected Ext. DC-Disconnected Int. DC-11.2VDC ±0.2v		•	•	•	•	•ON	•	•ON
9b.	Press VISUAL RESET	•	•	•	•	•	•ON	•	ON•
10.	AC-Disconnected Ext. DC-Disconnected Int. DC-Decreasing	•	•	•OFF	•	ON OFF	•ON OFF	•	ON OFF

•Not significant

3. Verify the power supply monitors' and alarms' priority and threshold:
   a. With the power switch OFF, connect the unit to a variable AC power source set for nominal rated line voltage. Adjust a variable DC power supply to 12.7 VDC ±0.2v and connect it to the external battery receptacle. Make sure the internal battery is fully charged.
   b. Turn the power switch ON and verify that both INT BATT and EXT BATT meters are in the green area. Also verify that the power monitors and alarms are as indicated on Line 1 of Table 5-6.
   c. Slowly reduce the AC line voltage until it drops below the 80% value in Table 5-5 for the rated nominal line voltage of the specific unit. Verify that the monitors and alarms are as indicated on Line 2 of Table 5-6.
   d. Slowly increase the AC line voltage above the 80% value in Table 5-5 for the rated nominal line voltage of the specific unit. Verify that the monitors and alarms change to those on Line 3a of Table 5-6 before the line voltage equals the 84% value in Table 5-5. Press the VISUAL RESET button and verify that the PWR CHANGE LED goes OFF (Table 5-6, Line 3b).
   e. Disconnect the AC power source and verify that the monitors and alarms are as on Line 4a of Table 5-6. Press the VISUAL RESET button and verify that the PWR CHANGE LED and the audible alarm go OFF (Table 5-6, Line 4b).
   f. With the AC source disconnected, slowly reduce the external DC voltage supply until the EXT BATT meter transitions from the green area to the red area and the audible alarm activates. At this point the external DC voltage must be 10.5 VDC ±0.3v and the monitors and alarms are as on Line 5 of Table 5-6.
   g. Slowly increase the external DC voltage until the audible alarm goes OFF. The voltage must be 12.1 VDC ±0.3v and the monitors and alarms are as on Line 6a of Table 5-6. Press the VISUAL RESET button and verify that the PWR CHANGE LED goes OFF (Table 5-6, Line 6b).
   h. Reconnect the AC power source (nominal value). Verify that the monitors and alarms are as on Line 7 of Table 5-6 and press VISUAL RESET.
   i. Turn the unit's power switch OFF. Disconnect the DC power supply from the external battery receptacle. Disconnect the terminals from the internal battery and connect the DC power supply to the internal battery wire leads. Adjust the DC power supply to 13.8 VDC ±0.05v.
   j. Turn ON the unit's power switch and allow it to cycle at least twice to stabilize all functions. Then, slowly reduce the AC line voltage until it drops below the 80% value in Table 5-5 for the rated nominal line voltage of the ventilator. Verify that the monitors and alarms are as on Line 8a of Table 5-6. Press the VISUAL RESET and verify that the PWR CHANGE LED and audible alarm go OFF (Table 5-6, Line 8b).
   k. Disconnect the AC supply and slowly decrease the internal DC voltage until the audible alarm goes ON. The internal DC voltage must be 11.2 VDC ±0.2v and the LO BATT alert LED is ON (Table 5-6, Line 9a). Also, the INT BATT meter must be indicating in the red area. Press VISUAL RESET and verify that the audible alarm and the LO BATT alert LED remain ON.
   l. Continue reducing the internal DC voltage until the pump stops. Verify that the VENT INOP alarm LED and the audible alarm go ON and then go OFF as the voltage continues to decrease (Table 5-6, Line 10).
   m. Turn the power switch OFF, disconnect the DC power supply, and reconnect the internal battery leads.

Display/Control Verification

Perform this procedure to verify proper tidal volume delivery, peak flow rate, and breath rate; to verify operation of the inspiratory time display; and to verify assist control, SIMV and SIGH operating modes.

Specifications:
See Table 5-7

Equipment:
Calibration Analyzer Timeter Series RT-200 or equivalent
Stopwatch

1. Connect the Standard Test Circuit as shown in Figure 5-2, except connect the patient manifold outlet to the High Range input on the Flow Module of the RT-200 instead of to the test lung. Turn on the RT-200 and allow it to warm up for 5 minutes before making any measurements with it.
2. Plug the unit into an appropriate AC power source and switch the power ON.
3. Set the controls to the values on Line 1 of Table 5-7. Set the HIGH PRESS ALARM to 80 and the LOW PRESS ALARM to 3.
4. Follow the RT-200 manufacturer's instructions and measure the TIDAL VOLUME. Set the RT-200 to accumulate 4 breaths and verify that the accumulated total error is within the tolerance in Table 5-7. Reset the RT-200 and remeasure two more times to be sure the error is within tolerance.
5. Reset the RT-200 Controls to measure RATE and then PEAK FLOW. Repeat each measurement three times and verify these values as within the allowable tolerance on Line 1, Table 5-7.
6. Decrease the PEAK FLOW setting and verify that it flashes at 27 LPM.
7. Change the unit settings to those on Line 2, Table 5-7. Repeat steps 4 and 5 for the values and tolerances on Line 2.
8. Increase the TIDAL VOLUME setting and verify that it flashes at 690 ml.
9. Change the unit settings to those on Line 3, Table 5-7. Repeat steps 4 and 5 for the values and tolerances on Line 3.
10. Increase the RATE setting and verify that it flashes at 19.
11. Change the units settings to those on Line 4, Table 5-7. Reset the RT-200 controls to measure TIDAL VOLUME but accumulate only one breath. Activate the unit SIGH function and verify that a normal breath reads as on Line 4, the SIGH breath reads as on Line 5, that the normal breath following the SIGH breath returns to the value on Line 4.
12. Use the stopwatch to time the interval between SIGH breaths and verify that a SIGH breath occurs every 600 ±6 seconds.
13. Repeat Step 5 for the values on Line 4, Table 5-7.
14. Repeat Step 10, then Step 5 for the values on Lines 6 and 7, Table 5-7.
15. Change the unit settings to those of Line 8, Table 5-7 and repeat Step 5 for these values and tolerances.
16. Momentarily induce a -3 cmH_2O pressure drop at the patient manifold between the controlled breath intervals. Verify that the unit delivers an assist breath when manifold pressure drops to -2 ±2 cmH_2O.
17. Change the unit settings to those of Line 9, Table 5-7 and repeats Steps 4 and 5 for these values and tolerances.

Table 5-7

Line Mode	Tidal Volume		Rate		Peak Flow		Assist Sens
	Value (ml)	Tolerance (ml/breath)	Value (BPM)	Tolerance (BPM)	Value (LPM)	Tolerance (LPM)	cmH_2O
1. Control	350	±5%	24	±1.2	30	±10%	-1
2.	500	±5%	16	±1.0	35	±10%	-1
3.	1000	±5%	12	±1.0	60	±10%	-1
4. SIGH On	1500	±5%	10	±1.0	60	±10%	-1
5.	2250	±5%	—	—	—	±10%	—
6.	600	±5%	6	±1.0	40	±10%	-1
7.	900	±5%	—	—	—	±10%	—
8. Assist Control	600	—	8	±1.0	40	±10%	-2
9.	1500	±5%	3	±1.0	90	±10%	5
10.	600	±5%	3	±1.0	40	±10%	-2

18. Induce a sustained 7 cmH_2O PEEP level at the patient manifold. Verify that the unit delivers an assist breath when manifold pressure is momentarily reduced to 5 ±1 cmH_2O.
19. Change the unit settings to those of Line 10, Table 5-7 and repeats Steps 4 and 5 for these values and tolerances.
20. Induce a sustained -3 cmH_2O at the patient manifold and use the stopwatch to verify that the unit delivers an assist breath no sooner than 740 msec. after the end of the last inspiration.

Monitor ADC Reference Voltage Verification/ Calibration

Perform this procedure to verify and calibrate, if necessary, the +5 VDC ADC reference source.

NOTE

This procedure is only necessary if pressure alarms and threshold do not meet specifications.

Specifications:
+5.00 VDC ±0.01v at TP-12

Equipment:
Digital Multimeter

1. Connect the Standard Test Circuit and plug the unit into an appropriate AC power source. Turn the unit ON and adjust all controls to Standard Settings.
2. Measure the voltage at Monitor PCB TP-12 with respect to analog (A) ground (Figure 5-7). The voltage must read +5.00 ±0.01 VDC.
3. If necessary, adjust R2 for the correct reading (Figure 5-7).

Pressure Transducer Verification/Calibration

Perform this procedure to verify and calibrate, if necessary, the pressure transducer circuitry on the Monitor PCB.

NOTE

This procedure is only necessary if pressure alarms and thresholds do not meet specifications. The Monitor ADC Reference Voltage should be verified prior to this procedure.

Specification:

Table 5-8

Input Pressure (cmH_2O)	Monitor Test Point	Voltage Measurement (volts)	Tolerance (volts)
0	TP 11	0.781	±0.005
50	TP 11	2.73	±0.01

Equipment:
Digital Multimeter
Calibration Analyzer, Timeter RT-200 or equivalent
Pressure regulator and valve

NOTE

The 7.15 VDC power supply must be verified within tolerance prior to this procedure.

1. Connect the Pressure Test Circuit as in Figure 5-3, but do not apply pressure to the system.
2. Plug the unit into an appropriate AC power source and turn the power switch ON. Adjust all controls to Standard Settings.
3. With the in-line shutoff valve closed, vent the line to atmosphere by disconnecting the tubing at the RT-200 input. Do not reconnect the tubing.
4. Measure the voltage at TP-11 of the Monitor PCB to analog (A) ground (Figure 5-7). The voltage must be 0.781 ±0.005 VDC.
5. If necessary, adjust R1 on the Monitor PCB (Figure 5-7) for the correct reading.
6. Follow the manufacturer' instructions to adjust the RT-200 to measure pressure, zero adjust the RT-200, and then connect the tubing to the P+ input.
7. Open the in-line valve and adjust the pressure for exactly 50 cmH2O on the RT-200.
8. Again, measure the voltage at Monitor PCB TP-11 to analog (A) ground. It must be 2.73 ±0.01 VDC.
9. If necessary, adjust R3 on the Monitor PCB (Figure 5-7) for the correct voltage.
10. If either R1 or R3 is adjusted, it will be necessary to repeats Steps 3 through 9 until both measurements are in tolerance.

Stress Test

1. Set controls to Standard Settings.
2. Run the unit for at least eight hours.
3. Perform the Operational Verification Procedure (OVP).

SECTION 6
BEAR® 33 VOLUME VENTILATOR SCHEMATICS

This section contains electronic and pneumatic schematic diagrams, wiring diagrams, tubing diagrams, PCB assembly drawings, and block diagrams. The prints herein disclose subject matter in which Bear Medical Systems, Inc. has proprietary rights. The receipt or possession of these prints does not confer, transfer or license the use of the designs or the technical information shown herein. Disclosure thereof to others, or manufacture of any article herefrom, is forbidden except by specific permission from Bear Medical Systems, Inc.

CONTENTS

Page

General

Pneumatic Diagram 6-2
Pneumatic Schematic 6-3
Electronic Block Diagram 6-4
Electronic Wiring Diagram 6-5

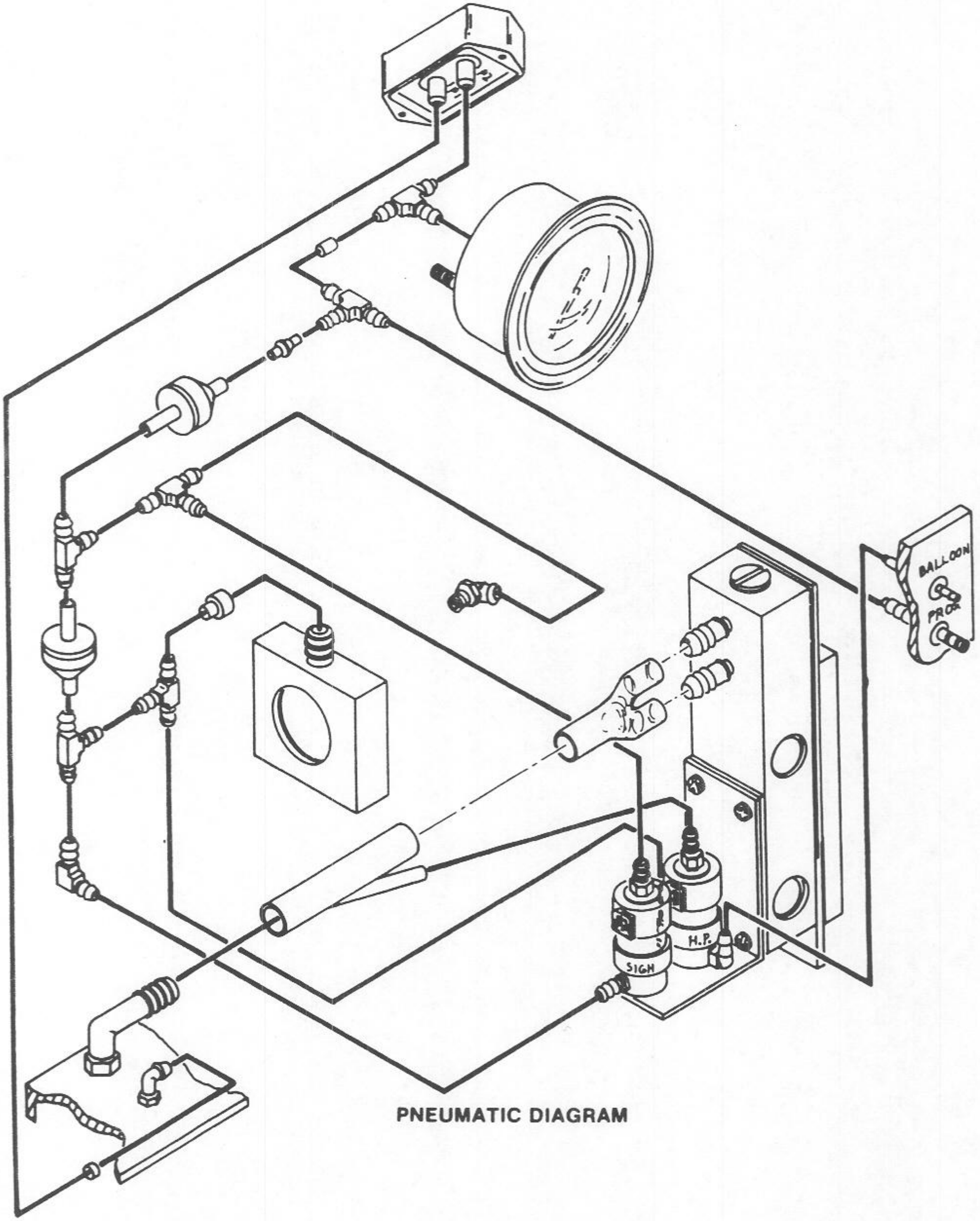
PCB Layout Drawings

Sensor PCB and Motor PCB 6-6
Display PCB 6-7
Monitor PCB 6-8
Controller PCB 6-9

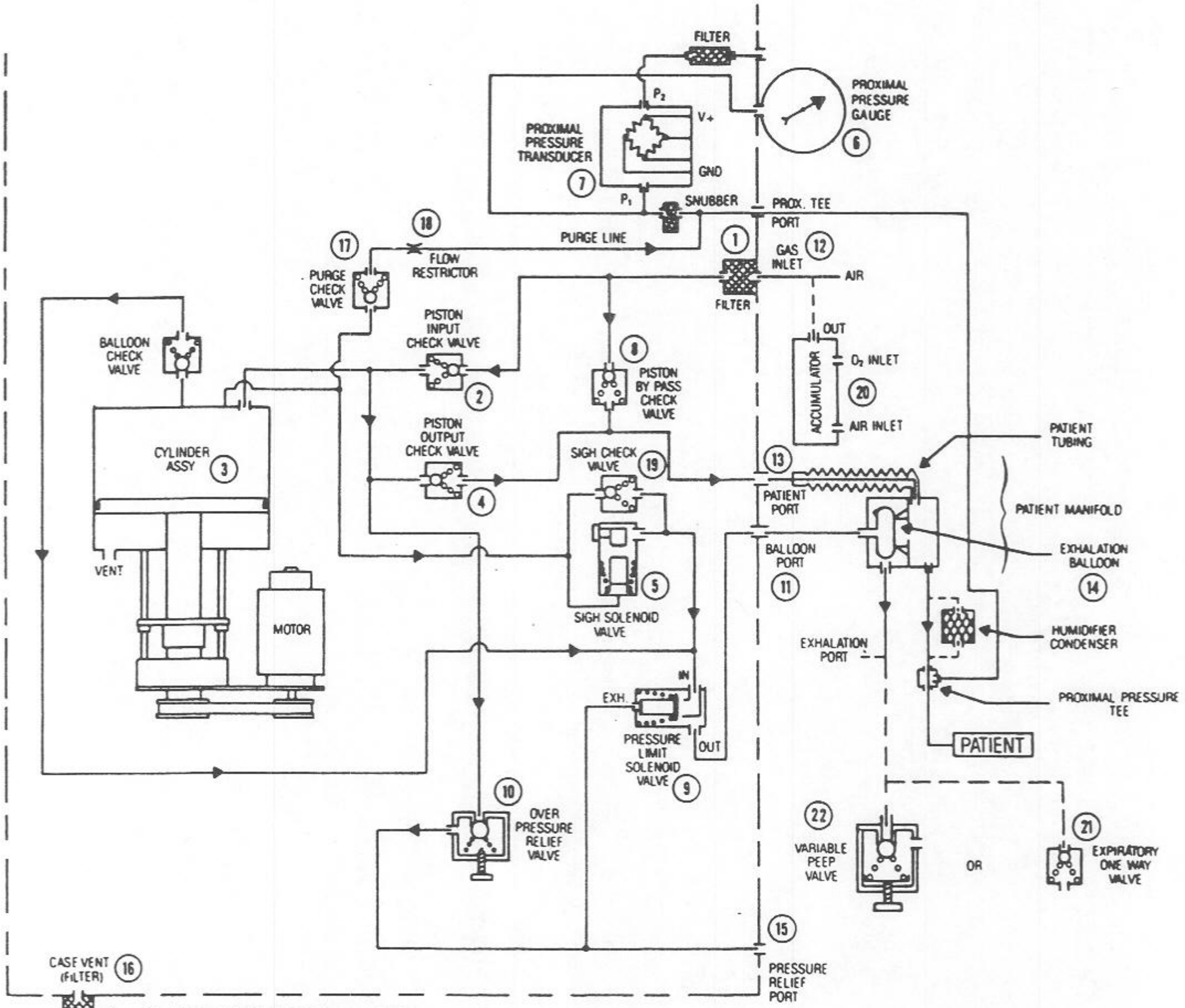
Electronic Schematic Diagrams

Sensor PCB 6-11
Display PCB 6-12
Monitor PCB 6-13, 6-14, 6-15, 6-16
Controller PCB 6-17, 6-18, 6-20
Motor PCB 6-21

76


BALLOON
PRIOR
H.P.
SIGH

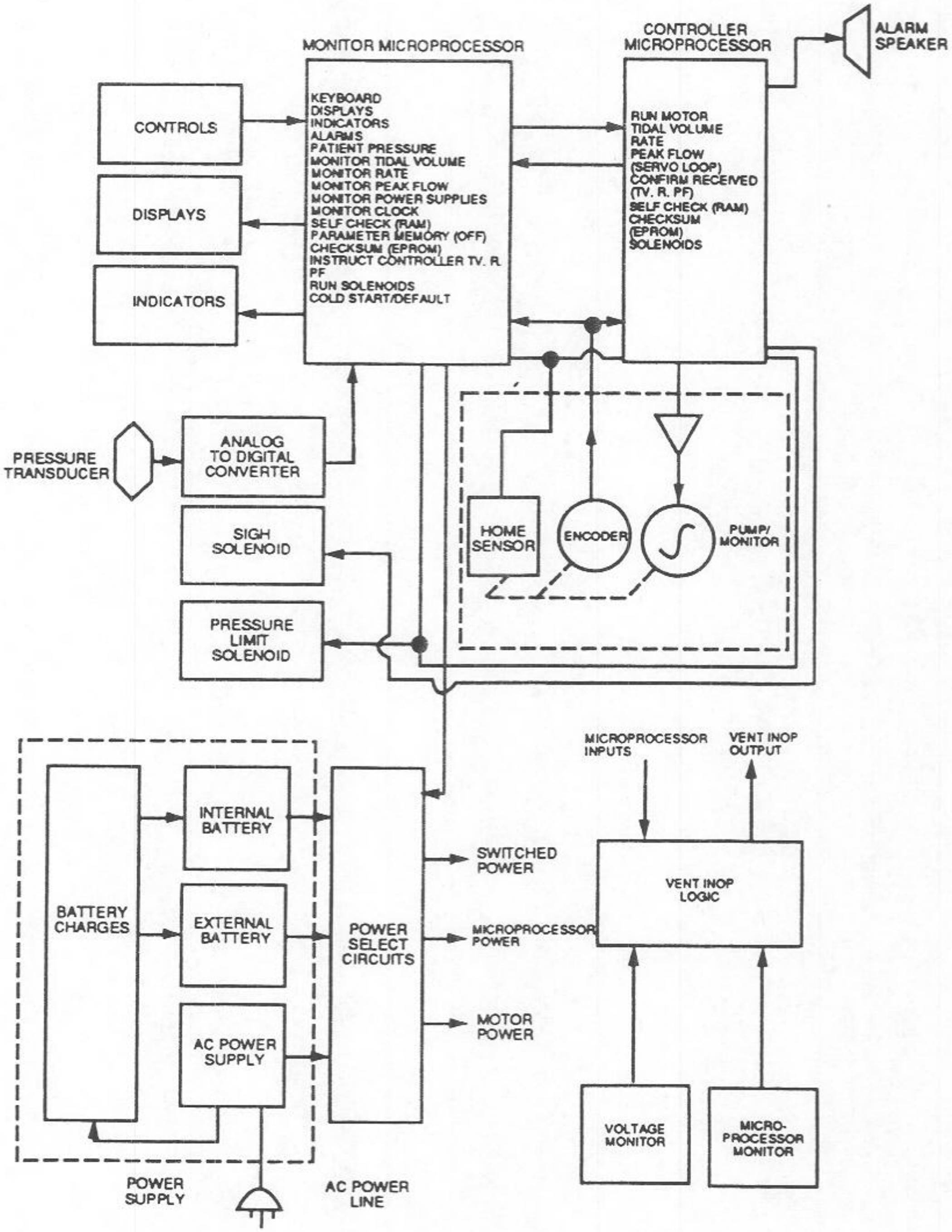
PNEUMATIC DIAGRAM


FILTER
PROXIMAL PRESSURE GAUGE
6
P₂
V+
PROXIMAL PRESSURE TRANSDUCER
GND
7
P₁
SNUBBER
PROX. TEE PORT
18
17
PURGE LINE
1
GAS INLET
12
PURGE CHECK VALVE
FLOW RESTRICTOR
AIR
FILTER
BALLOON CHECK VALVE
PISTON INPUT CHECK VALVE
OUT
2
8
PISTON BY PASS CHECK VALVE
ACCUMULATOR
O₂ INLET
20
AIR INLET
CYLINDER ASSY
3
PISTON OUTPUT CHECK VALVE
SIGH CHECK VALVE
19
13
PATIENT TUBING
4
PATIENT PORT
PATIENT MANIFOLD
VENT
BALLOON PORT
EXHALATION BALLOON
5
11
14
MOTOR
SIGH SOLENOID VALVE
EXHALATION PORT
HUMIDIFIER CONDENSER
IN
EXH.
PROXIMAL PRESSURE TEE
PRESSURE LIMIT SOLENOID VALVE
OUT
9
PATIENT
10
OVER PRESSURE RELIEF VALVE
22
21
VARIABLE PEEP VALVE
OR
EXPIRATORY ONE WAY VALVE
15
CASE VENT (FILTER)
16
PRESSURE RELIEF PORT

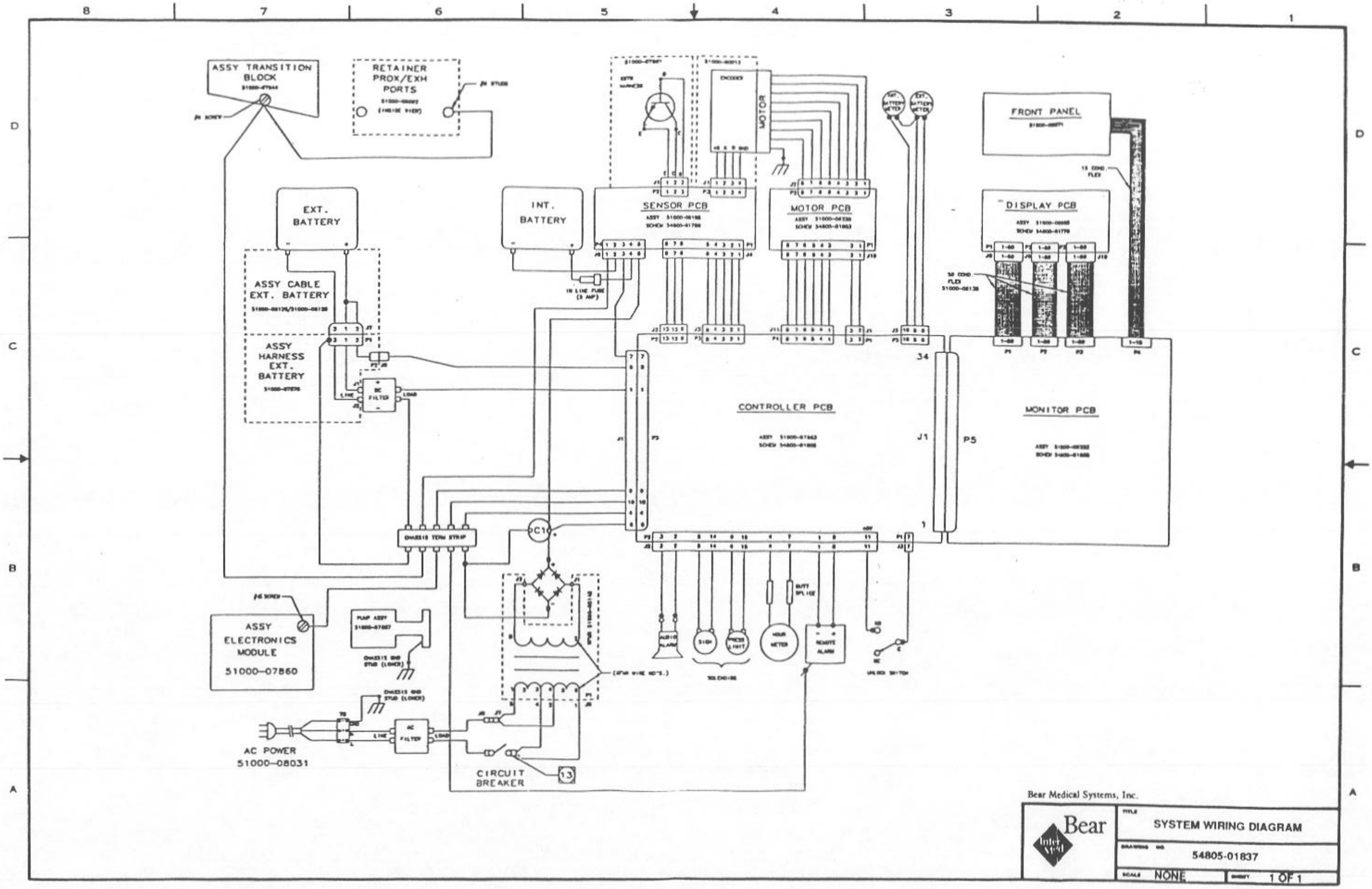
Case Vent Filter deleted on newer models.

NOTE: Schematic shown in "Power On" Condition. Sigh Solenoid is de-energized and pressure limit solenoid is energized.

BEAR® 33 VOLUME VENTILATOR PNEUMATIC SCHEMATIC


MONITOR MICROPROCESSOR
CONTROLLER MICROPROCESSOR
ALARM SPEAKER
CONTROLS
DISPLAYS
INDICATORS
KEYBOARD
DISPLAYS
INDICATORS
ALARMS
PATIENT PRESSURE
MONITOR TIDAL VOLUME
MONITOR RATE
MONITOR PEAK FLOW
MONITOR POWER SUPPLIES
MONITOR CLOCK
SELF CHECK (RAM)
PARAMETER MEMORY (OFF)
CHECKSUM (EPROM)
INSTRUCT CONTROLLER TV. R. PF
RUN SOLENOIDS
COLD START/DEFAULT
RUN MOTOR
TIDAL VOLUME
RATE
PEAK FLOW
(SERVO LOOP)
CONFIRM RECEIVED
(TV. R. PF)
SELF CHECK (RAM)
CHECKSUM
(EPROM)
SOLENOIDS
PRESSURE TRANSDUCER
ANALOG TO DIGITAL CONVERTER
SIGH SOLENOID
PRESSURE LIMIT SOLENOID
HOME SENSOR
ENCODER
PUMP/ MONITOR
MICROPROCESSOR INPUTS
VENT INOP OUTPUT
VENT INOP LOGIC
BATTERY CHARGES
INTERNAL BATTERY
EXTERNAL BATTERY
AC POWER SUPPLY
POWER SELECT CIRCUITS
SWITCHED POWER
MICROPROCESSOR POWER
MOTOR POWER
VOLTAGE MONITOR
MICRO-PROCESSOR MONITOR
POWER SUPPLY
AC POWER LINE

SMB33 ELECTRONIC BLOCK DIA.


ASSY TRANSITION BLOCK
RETAINER PROX/EXH PORTS
EXT. BATTERY
ASSY CABLE EXT. BATTERY
ASSY HARNESS EXT. BATTERY
DC FILTER
LINE
LOAD
INT. BATTERY
IN LINE FUSE (3 AMP)
SENSOR PCB
MOTOR
MOTOR PCB
FRONT PANEL
15 COND. FLEX
DISPLAY PCB
50 COND. FLEX 51000-08138
CONTROLLER PCB
MONITOR PCB
J1
P5
34
1
CHASSIS TERM STRIP
DC1
ASSY ELECTRONICS MODULE 51000-07860
PUMP ASSY
CHASSIS GND STUD (LOWER)
AC POWER 51000-08031
AC FILTER
CIRCUIT BREAKER
13
AUDIO ALARM
SIGH
PRESS LIMIT
SOLENOIDS
HOUR METER
BUTT SPLICE
REMOTE ALARM
UNLOCK SWITCH
NO
NC
C
1
2
3
4
5
6
7
8
A
B
C
D

Bear Medical Systems, Inc.

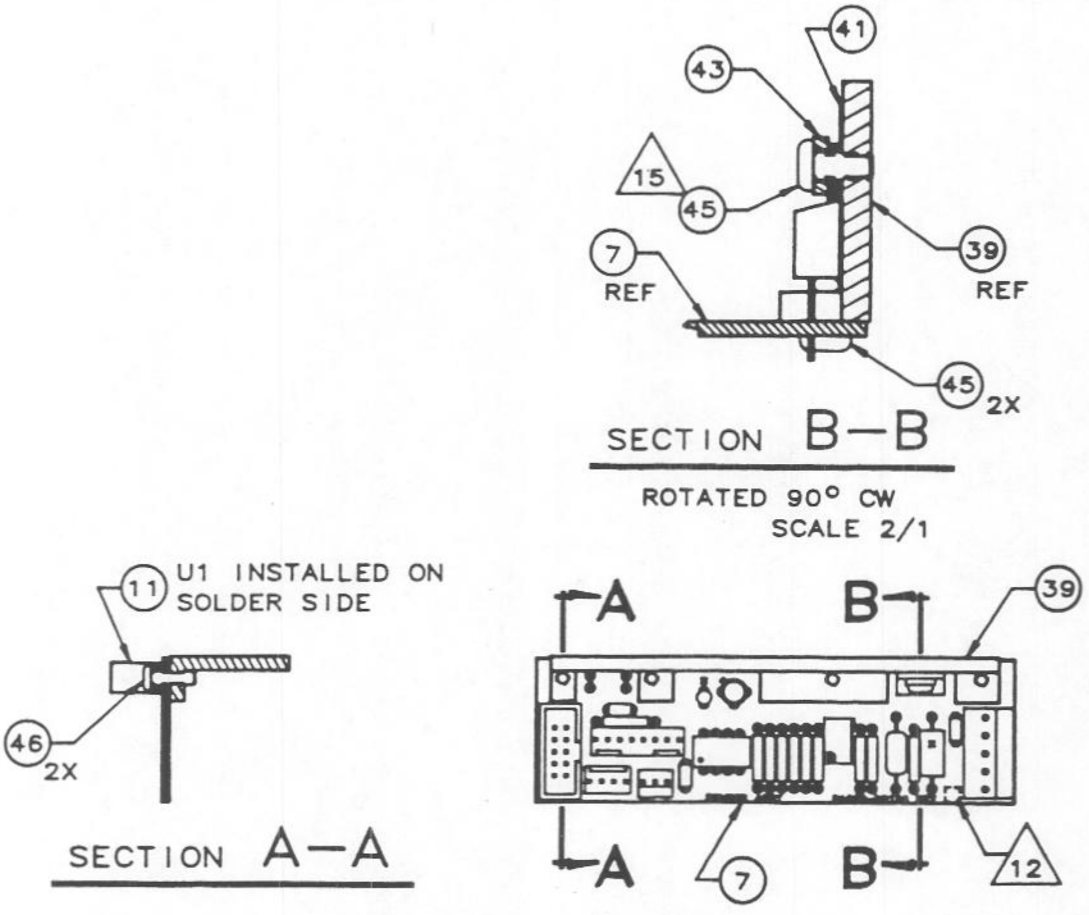
Bear
Inter Med

TITLE SYSTEM WIRING DIAGRAM

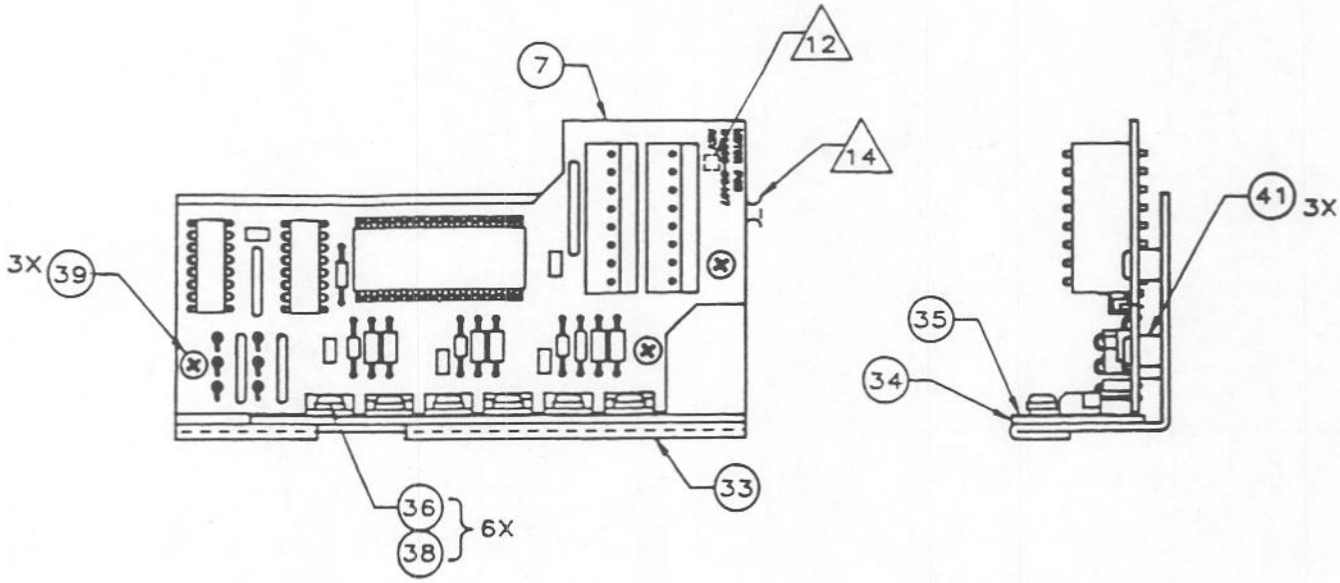
DRAWING NO. 54805-01837

SCALE NONE

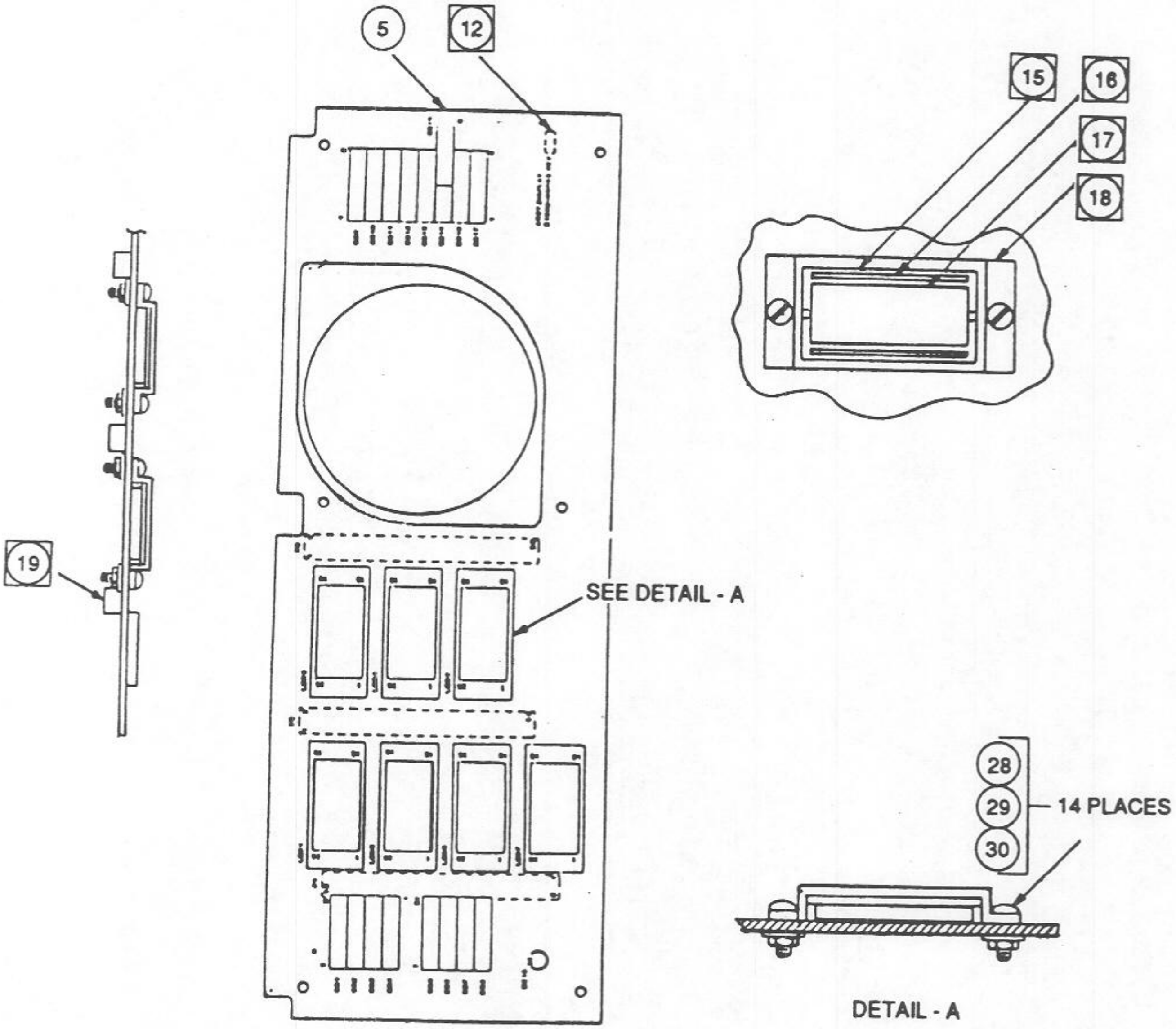
SHEET 1 OF 1


41
43
15
45
7
REF
39
REF
45
2X
SECTION B—B
ROTATED 90° CW
SCALE 2/1
11
U1 INSTALLED ON
SOLDER SIDE
46
2X
SECTION A—A
A
B
39
A
7
B
12

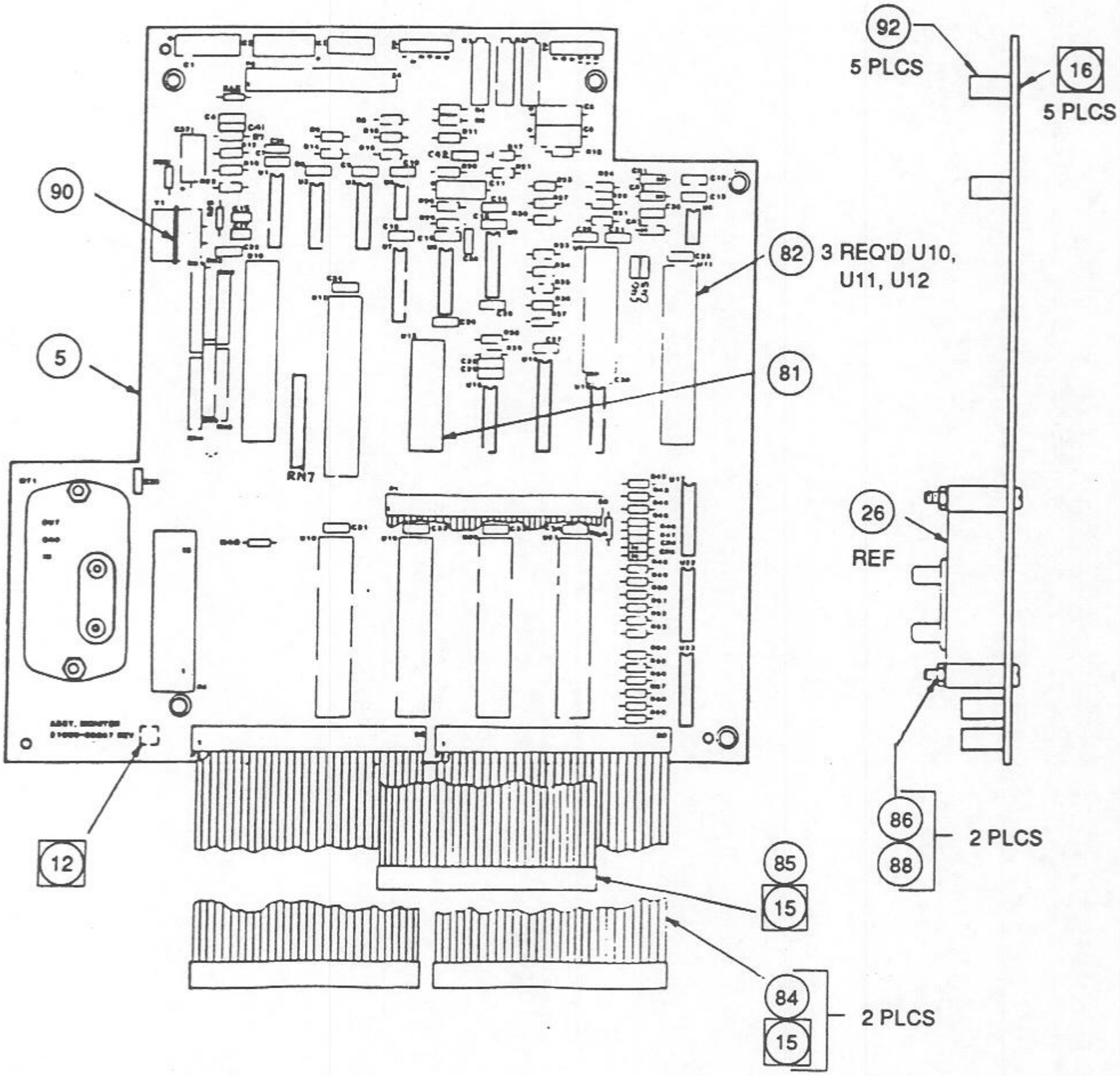
Sensor PCB


7
12
14
3X
39
41
3X
35
34
33
36
38
6X

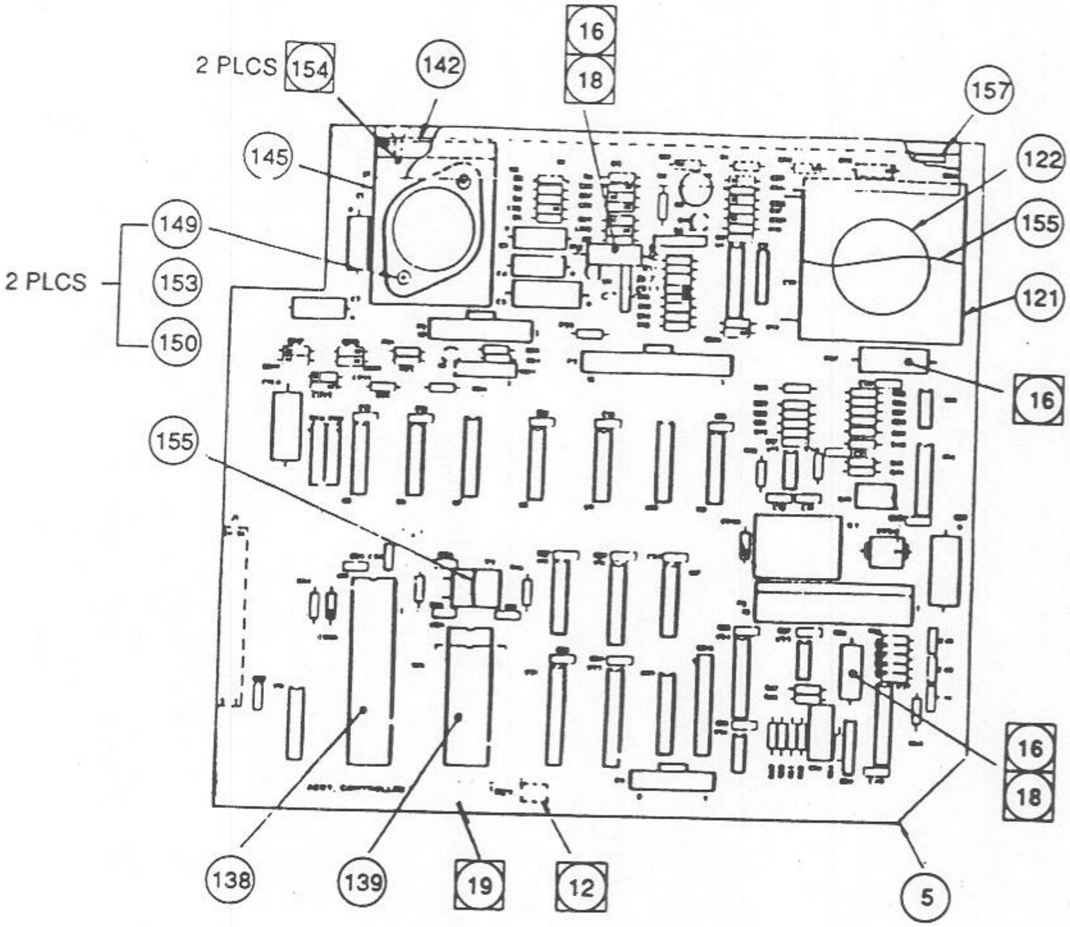
Motor PCB

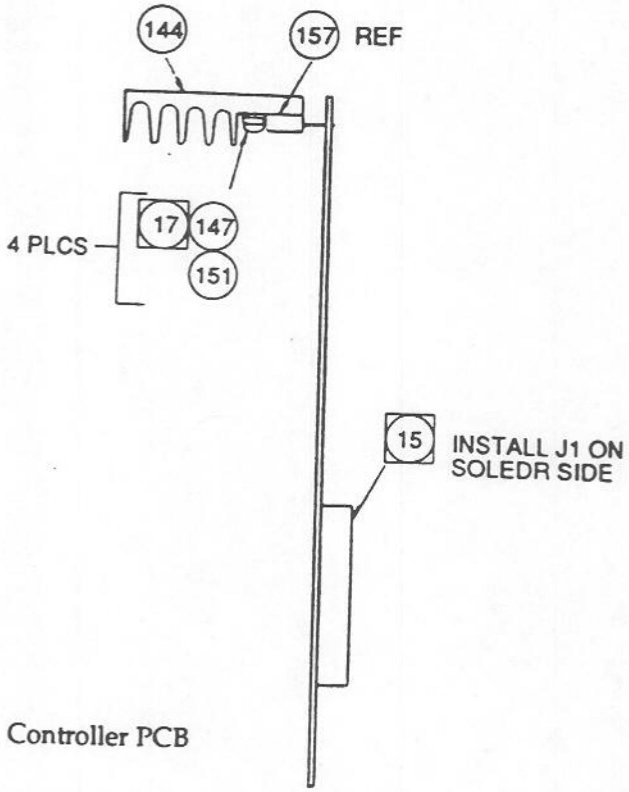

5
12
15
16
17
18
19
SEE DETAIL - A
28
29
30
14 PLACES
DETAIL - A

Display PCB


5 PLCS
5 PLCS
3 REQ'D U10, U11, U12
RN7
REF
2 PLCS
2 PLCS

Monitor PCB

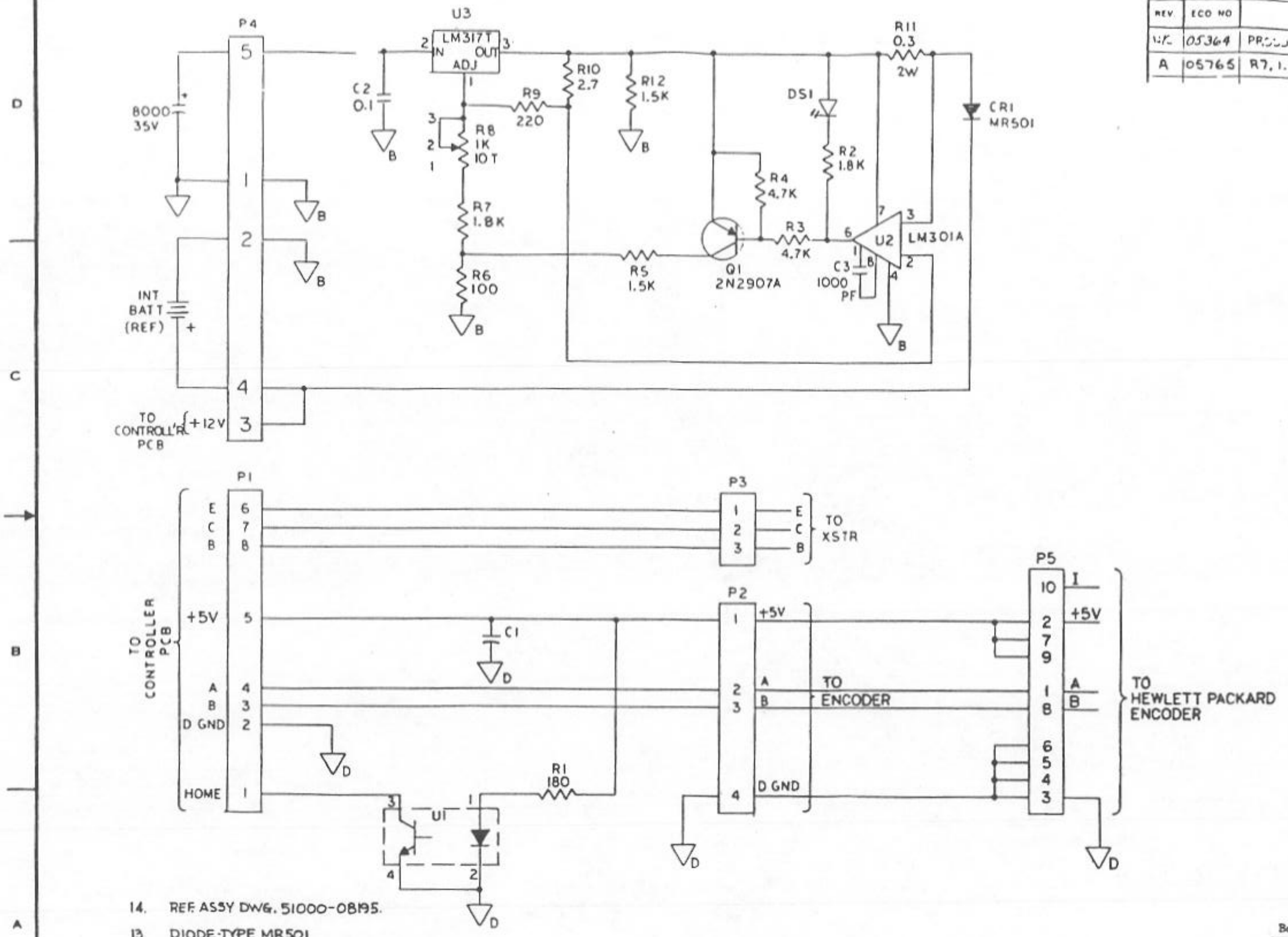

2 PLCS
154
142
16
18
157
145
122
155
149
2 PLCS
153
150
121
16
155
16
18
138
139
19
12
5


144
157
REF
4 PLCS
17
147
151
15
INSTALL J1 ON SOLEDR SIDE

Controller PCB

REVISIONS

REV.	ECO NO	DESCRIPTION	MADE BY		CHK'D BY	
V.C.	05364	PRODUCTION RELEASE	[illegible]	[illegible]	[illegible]	[illegible]
A	05765	R7, 1.8K WAS 1.2K	[illegible]	[illegible]	[illegible]	[illegible]


P4
5
1
2
4
3
8000
35V
INT
BATT
(REF)
TO
CONTROLL'R
PCB
+12V
U3
LM317T
IN
OUT
ADJ
C2
0.1
R9
220
R8
1K
10 T
R7
1.8K
R6
100
R10
2.7
R12
1.5K
R5
1.5K
Q1
2N2907A
R4
4.7K
R3
4.7K
DS1
R2
1.8K
R11
0.3
2W
CR1
MR501
U2
LM301A
C3
1000
PF
B
P1
E
C
B
6
7
8
TO
CONTROLLER
PCB
+5V
A
B
D GND
HOME
C1
D
U1
R1
180
P3
TO
XSTR
P2
TO
ENCODER
D GND
P5
I
10
+5V
TO
HEWLETT PACKARD
ENCODER

14. REF. ASSY DWG. 51000-08195.
13. DIODE-TYPE MR501
12. CAPACITOR-VALUES IN MFDS, 10%, 50V.
11. RESISTORS-VALUES IN OHMS, 5%, 1/4W.

NOTES: UNLESS OTHERWISE SPECIFIED

Bear Medical Systems, Inc.

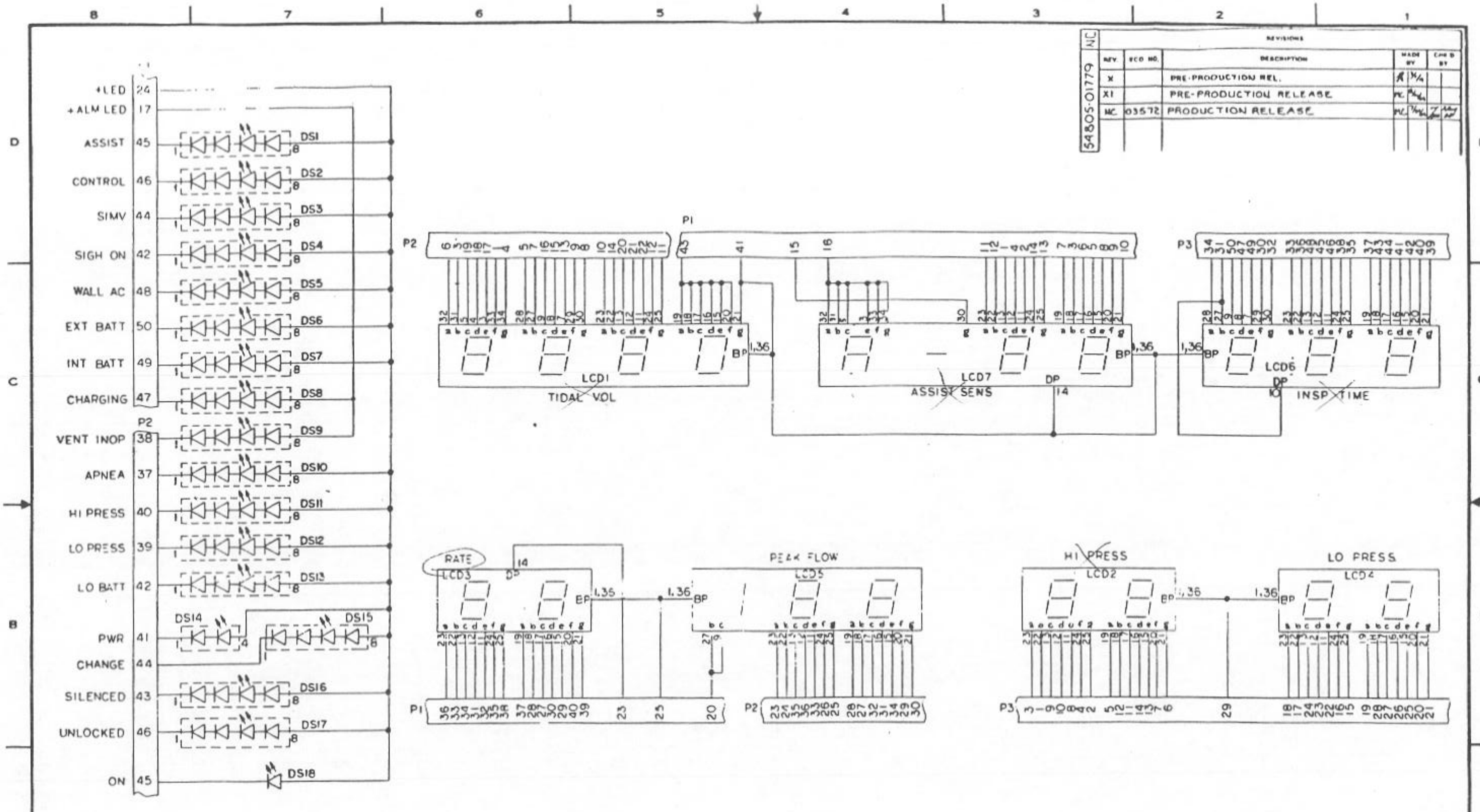
Bear

TITLE SCHEMATIC SENSOR PCB

DRAWING NO. 54805-01798

SCALE NONE

SHEET 1 OF 1


+LED
+ALM LED
ASSIST
CONTROL
SIMV
SIGH ON
WALL AC
EXT BATT
INT BATT
CHARGING
VENT INOP
APNEA
HI PRESS
LO PRESS
LO BATT
PWR
CHANGE
SILENCED
UNLOCKED
ON
P2
DS1
DS2
DS3
DS4
DS5
DS6
DS7
DS8
DS9
DS10
DS11
DS12
DS13
DS14
DS15
DS16
DS17
DS18
P1
P2
P3
LCD1
TIDAL VOL
LCD7
ASSIST SENS
LCD6
INSP TIME
RATE
LCD3
PEAK FLOW
LCD5
HI PRESS
LCD2
LO PRESS
LCD4
BP
DP
1,36

54805-01779 NC

REVISIONS				
REV.	ECO NO.	DESCRIPTION	MADE BY	CHK'D BY
X		PRE-PRODUCTION REL.	[illegible]	
X1		PRE-PRODUCTION RELEASE	[illegible]	
NC	03572	PRODUCTION RELEASE	[illegible]	[illegible]

Bear Medical Systems, Inc.

Bear

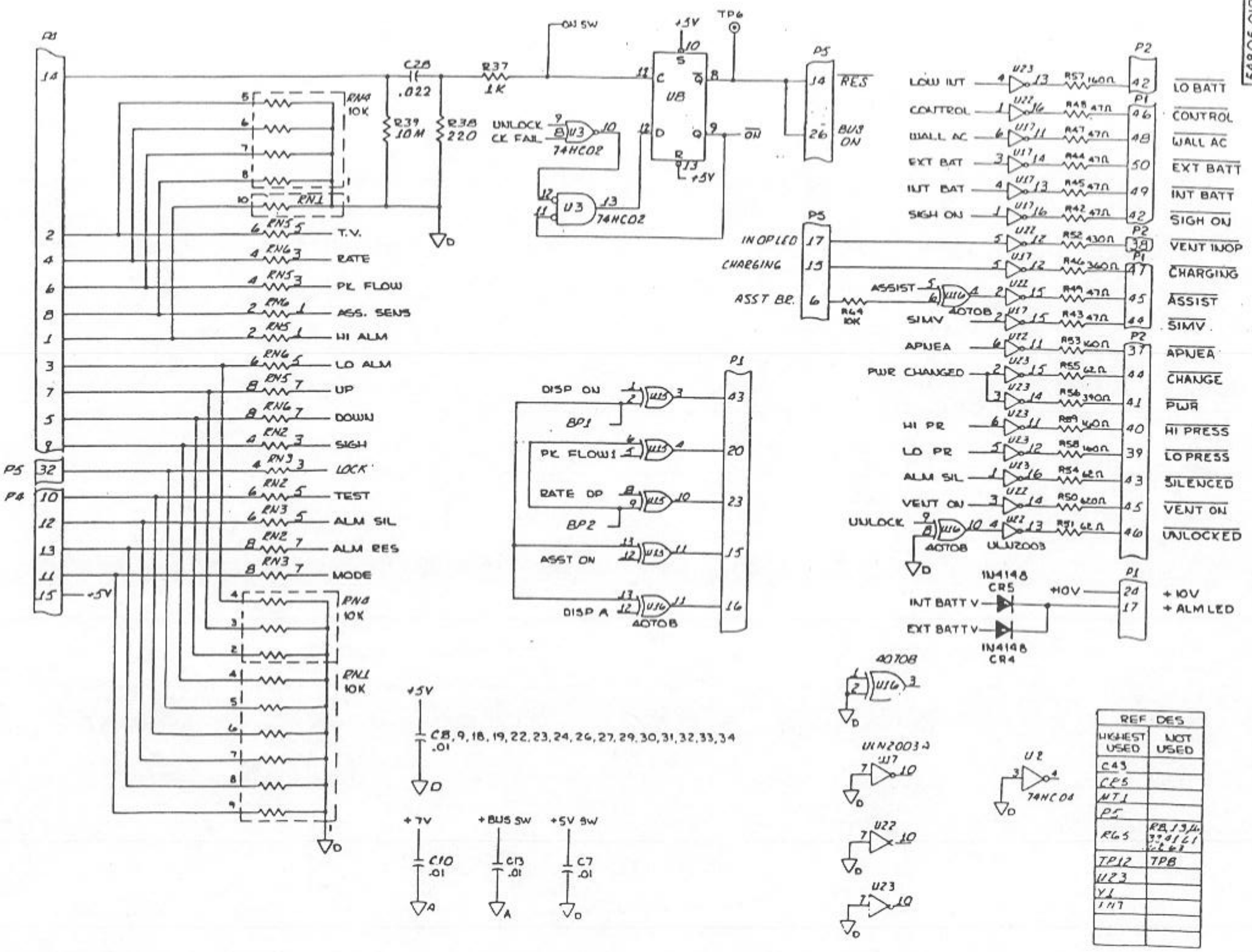
TITLE SCHEMATIC DISPLAY PCB

DRAWING NO. 54805-01779

SCALE NONE SHEET 1 OF 1

86

54805-01808 C	REVISIONS				
REV.	ECO NO	DESCRIPTION	MADE BY	CHK'D BY	
A	05775	PRODUCTION RELEASE			
B	06314	CORR PIN CONN OF U3			
C	06886	ADDED RN7 U8 WAS 4013			



P3
14
2
4
6
8
1
3
7
5
9
P5
32
P4
10
12
13
11
15
-5V
RN4 10K
RN1
RN5
RN6
RN2
RN3
RN8 10K
RN1 10K
T.V.
RATE
PK FLOW
ASS. SENS
HI ALM
LO ALM
UP
DOWN
SIGH
LOCK
TEST
ALM SIL
ALM RES
MODE
C28 .022
R37 1K
R39 10M
R38 220
ON SW
+5V
TP6
U8
UNLOCK
CK FAIL
U3
74HC02
ON
P5
RES
BUS ON
IN OP LED
CHARGING
ASST BE.
R44 10K
DISP ON
BP1
PK FLOW1
RATE DP
BP2
ASST ON
DISP A
U15
U16
4070B
P1
43
20
23
15
16
LOW INT
CONTROL
WALL AC
EXT BAT
INT BAT
SIGH ON
ASSIST
SIMV
APNEA
PWR CHANGED
HI PR
LO PR
ALM SIL
VENT ON
UNLOCK
ULN2003
U23
U22
U17
R57 160Ω
R48 47Ω
R47 47Ω
R44 47Ω
R45 47Ω
R42 47Ω
R52 430Ω
R46 360Ω
R49 47Ω
R43 47Ω
R53 160Ω
R55 62Ω
R56 390Ω
R59 160Ω
R58 160Ω
R54 62Ω
R50 620Ω
R51 62Ω
P2
42
46
48
50
49
37
44
41
40
39
45
47
38
LO BATT
CONTROL
WALL AC
EXT BATT
INT BATT
SIGH ON
VENT INOP
CHARGING
ASSIST
SIMV
APNEA
CHANGE
PWR
HI PRESS
LO PRESS
SILENCED
VENT ON
UNLOCKED
1N4148
CR5
CR4
INT BATT V
EXT BATT V
+10V
24
17
+ 10V
+ ALM LED
+5V
C8, 9, 18, 19, 22, 23, 24, 26, 27, 29, 30, 31, 32, 33, 34
.01
+7V
C10 .01
+BUS SW
C13 .01
+5V SW
C7 .01
4070B
ULN2003A
U17
U2
74HC04

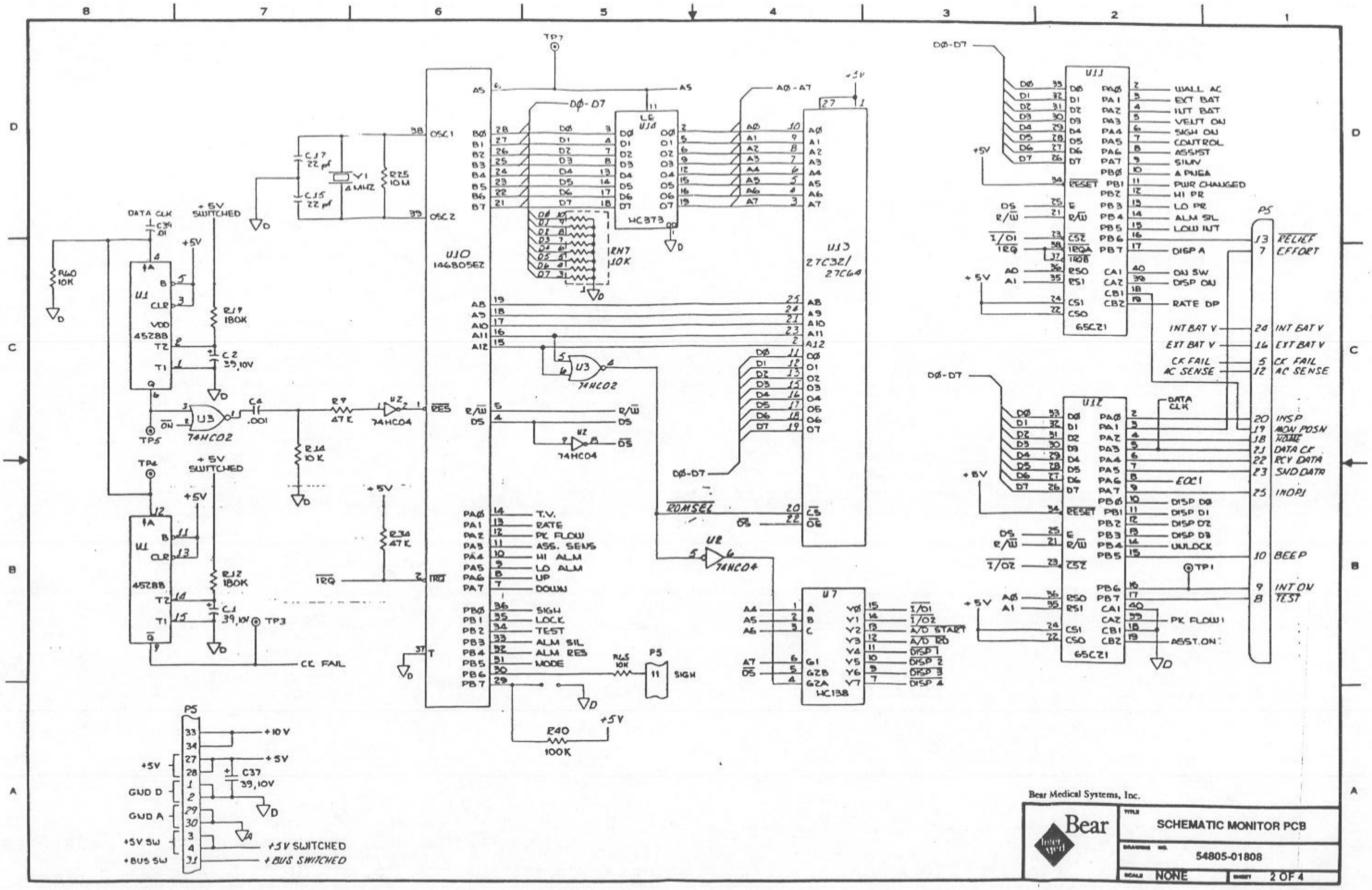
REF DES	
HIGHEST USED	NOT USED
C43	
CR5	
MT1	
P5	
R65	R8,13,14,33,41,61,62,63
TP12	TP8
U23	
Y1	
1N7	

IC TABLE					
REF DES	TYPE	+V		-V	
		PIN	VOLTAGE	PIN	VOLTAGE
U5	LM301A	7	+BUS SW	4	A GND
U4	LM358	8	+7	4	A GND
U6	723	11, 12	+BUS SW	7	A GND
U3	74HC02	14	+5	7	D GND
U8	74HC74	14	+5	7	D GND
U2	4069	14	+5	7	D GND
U15, 16	4070	14	+5	7	D GND
U1	4528	16	+5	8	D GND
U17, 22, 23	ULN2003A	—	—	8	D GND
U13	27C32/27C64	26, 28	+5	14	D GND
U11, 12	65SC21P1-1	20	+5	1	D GND
U7	74HC138	16	+5	8	D GND
U14	74HC373	20	+5	1, 10	D GND
U9	ADC0809	—	—	—	—
U10	146805E2	40	+5	20	D GND
U18-21	7211AM	1	+5	35	D GND

17. RN2, 3, 5 & 6 ARE 47K.
16. ADJUST VREF BEFORE INSTALLING U9.
15. REF ASSEMBLY DWG 51000-08252.
14. DIODES — TYPE 1N4148.
13. CAPACITORS — VALUES IN MFDS, 10 %.
12. 1% TOLERANCE RESISTORS ARE TYPE RN55C.
11. RESISTORS — VALUES IN OHMS, 5 %, 1/4 W.

Bear
TITLE
SCHEMATIC MONITOR PCB
DRAWING NO. 54805-01808
SCALE NONE
SHEET 1 OF 4

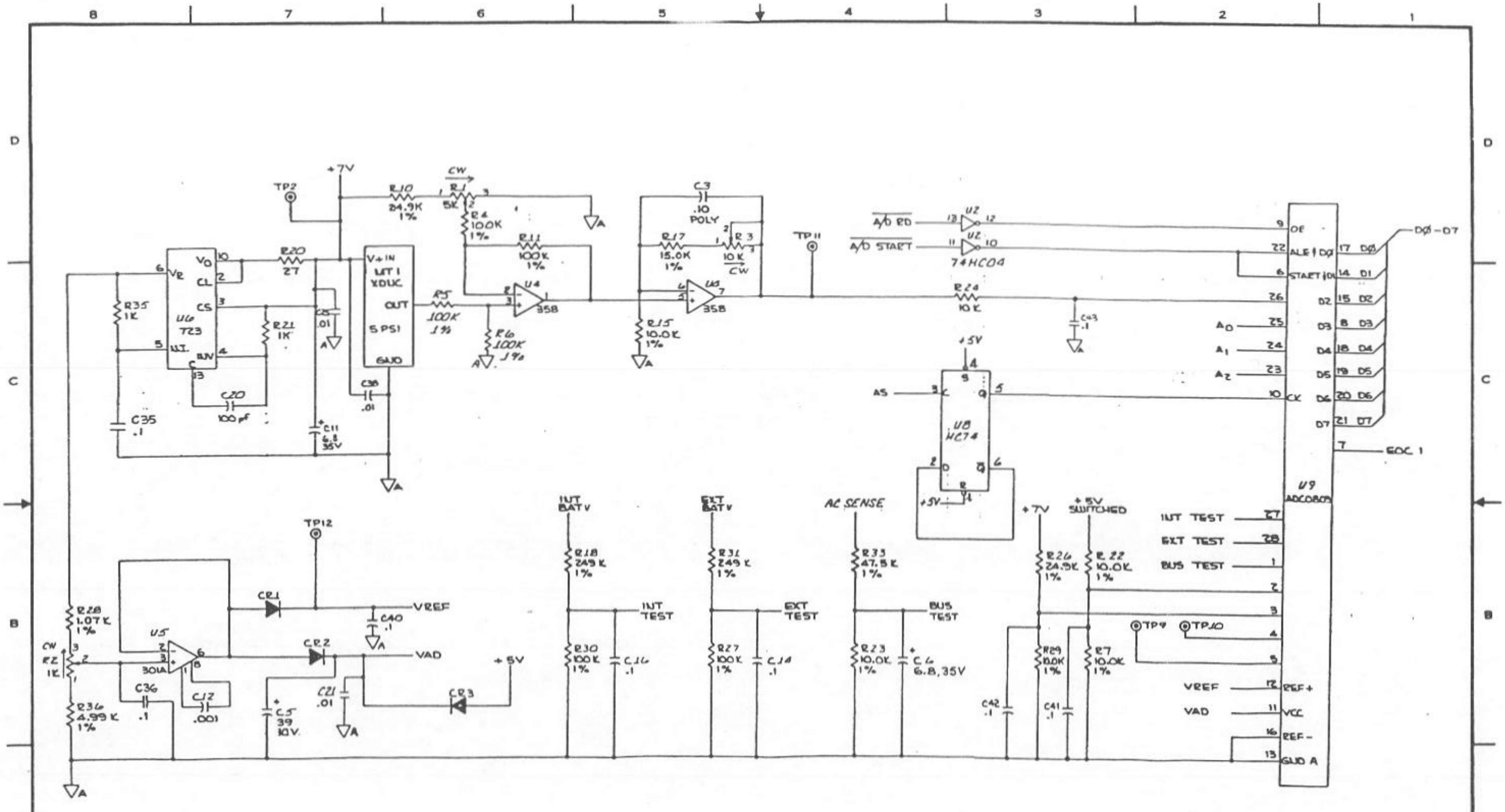
87


U10
146805EZ
U11
65C21
U12
65C21
U13
27C32/
27C64
U14
HC373
U7
HC138
U3
74HC02
U2
74HC04
U8
74HC04
U1
4528B
RN7
10K
Y1
4 MHZ
R25
10M
CJ7
22 pf
CJ5
22 pf
R19
180K
R12
180K
R9
47K
R14
10K
R34
47K
R40
100K
R65
10K
R60
10K
C39
.01
C4
.001
C2
39,10V
C1
39,10V
C37
39,10V
TP1
TP3
TP4
TP5
TP7
P5
DATA CLK
+5V SWITCHED
+5V
CK FAIL
IRQ
ROMSEL
D0-D7
A0-A7
T.V.
RATE
PK FLOW
ASS. SENS
HI ALM
LO ALM
UP
DOWN
SIGH
LOCK
TEST
ALM SIL
ALM RES
MODE
WALL AC
EXT BAT
INT BAT
VENT ON
SIGH ON
CONTROL
ASSIST
SIMV
APNEA
PWR CHANGED
HI PR
LO PR
ALM SIL
LOW INT
DISP A
ON SW
DISP ON
RATE DP
INT BAT V
EXT BAT V
CK FAIL
AC SENSE
RELIEF
EFFORT
INSP
MON POSN
HOME
DATA CK
RCV DATA
SND DATA
INOP1
EOC1
DISP D0
DISP D1
DISP D2
DISP D3
UNLOCK
BEEP
INT ON
TEST
PK FLOW1
ASST.ON
I/O1
I/O2
A/D START
A/D RD
DISP 1
DISP 2
DISP 3
DISP 4
+10V
+5V SW
+BUS SW
+5V SWITCHED
+BUS SWITCHED
GND D
GND A

Bear Medical Systems, Inc.

Bear Intermed

TITLE	SCHEMATIC MONITOR PCB
DRAWING NO.	54805-01808
SCALE NONE	SHEET 2 OF 4


8
7
6
5
4
3
2
1
D
C
B
A
+7V
TP2
R10
24.9K
1%
CW
R1
5K
R4
100K
1%
R11
100K
1%
A
R20
27
U6
723
VO
CL
CS
VR
N.I.
INV
C
R35
1K
R21
1K
C25
.01
C20
100 pF
C35
.1
C11
6.8
35V
V+IN
MT 1
XDUC
OUT
5 PSI
GND
C38
.01
R5
100K
1%
R6
100K
1%
U4
358
C3
.10
POLY
R17
15.0K
1%
R3
10K
CW
U3
358
R15
10.0K
1%
TP11
A/D RD
A/D START
U2
74HC04
R24
10K
C43
.1
+5V
AS
U8
HC74
D
Q
R
S
CK
A0
A1
A2
U9
ADC0809
OE
ALE I D0
START I D1
CK
D0
D1
D2
D3
D4
D5
D6
D7
D0-D7
EOC 1
INT TEST
EXT TEST
BUS TEST
VREF
VAD
REF+
VCC
REF-
GND A
TP9
TP10
+7V
+5V SWITCHED
R26
24.9K
1%
R22
10.0K
1%
R29
10.0K
1%
R7
10.0K
1%
C42
.1
C41
.1
AC SENSE
R33
47.5K
1%
R23
10.0K
1%
C6
6.8, 35V
BUS TEST
EXT BAT V
R31
249 K
1%
R27
100K
1%
C14
.1
EXT TEST
INT BAT V
R18
249 K
1%
R30
100K
1%
C16
.1
INT TEST
TP12
CR1
VREF
C40
.1
U5
301A
CR2
VAD
C21
.01
CR3
+5V
C5
39
10V
C36
.1
C12
.001
R28
1.07 K
1%
CW
R2
1K
R36
4.99 K
1%

Bear Medical Systems, Inc.

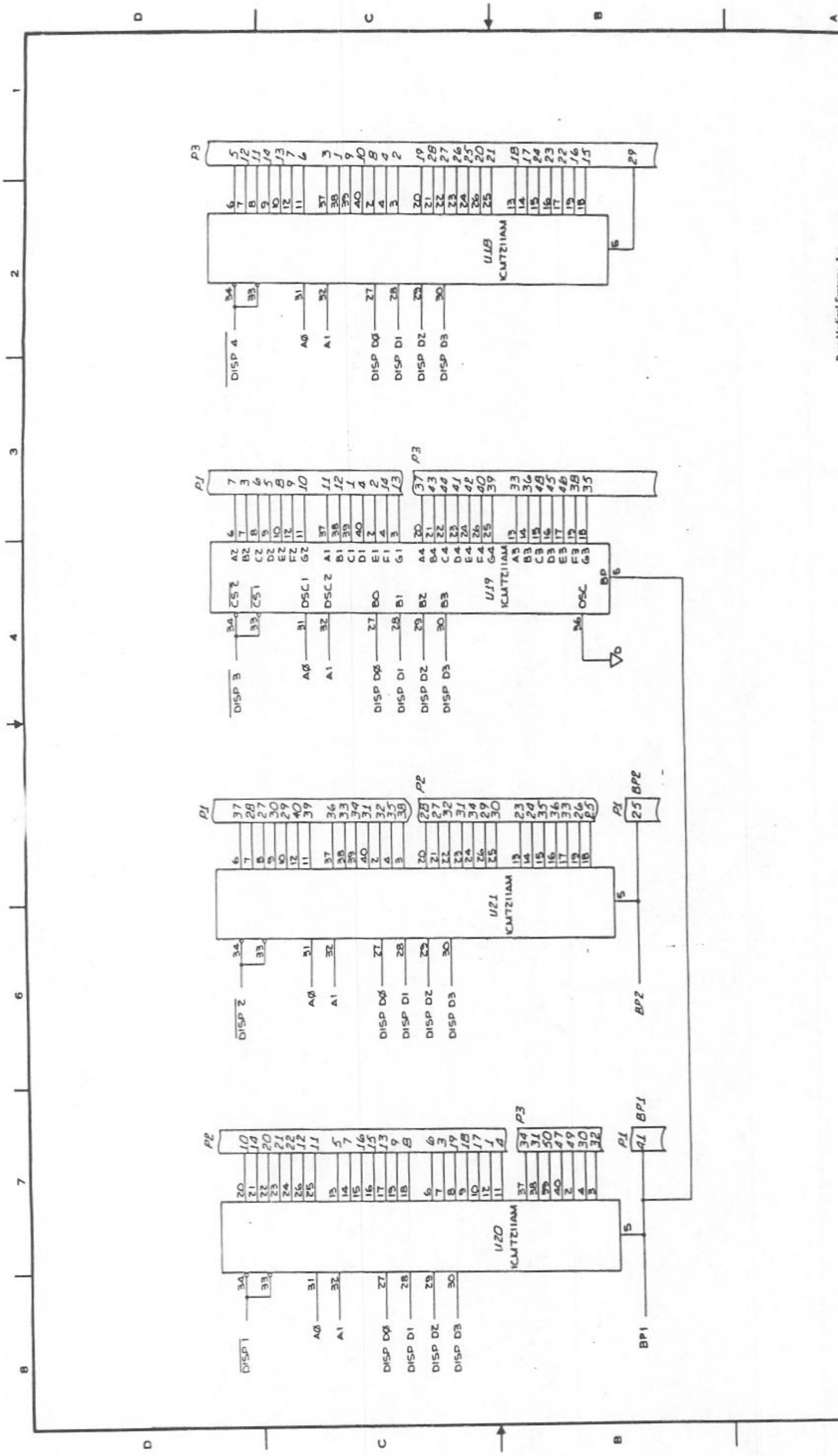
Bear

TITLE SCHEMATIC MONITOR PCB

DRAWING NO. 54805-01808

SCALE NONE

SHEET 3 OF 4


U18
ICM7211AM
U19
ICM7211AM
U20
ICM7211AM
U21
ICM7211AM
DISP 1
DISP 2
DISP 3
DISP 4
AØ
A1
DISP DØ
DISP D1
DISP D2
DISP D3
BP1
BP2
CS2
CS1
DSC1
DSC2
OSC
BP
P1
P2
P3

Bear Medical Systems, Inc.

Bear

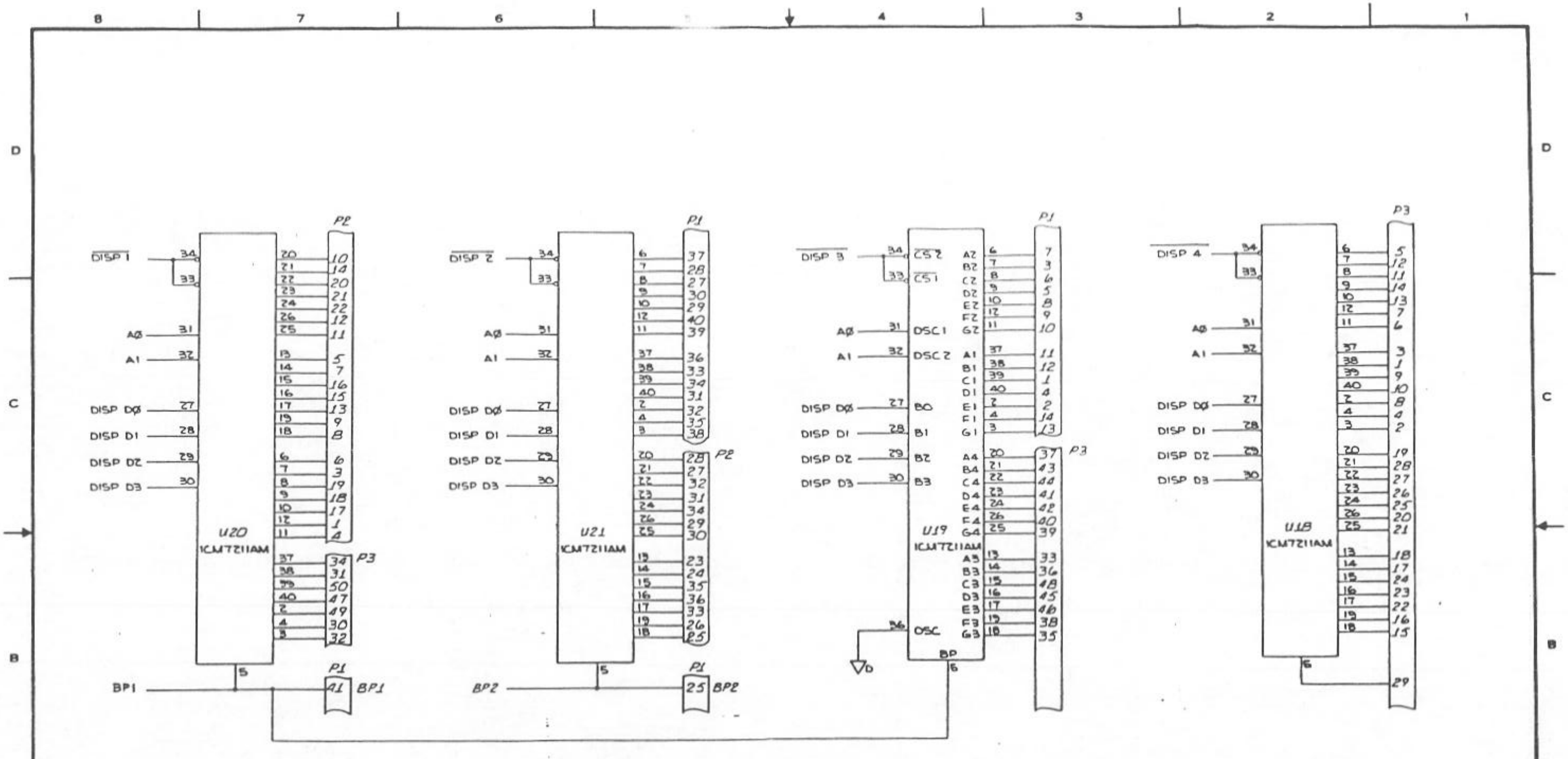
SCHEMATIC MONITOR PCB

54805-01808

NONE

4 OF 4

90


8
7
6
5
4
3
2
1
D
C
B
A
DISP 1
DISP 2
DISP 3
DISP 4
AØ
A1
DISP DØ
DISP D1
DISP D2
DISP D3
U20
ICM7211AM
U21
ICM7211AM
U19
ICM7211AM
U18
ICM7211AM
CS2
CS1
OSC1
OSC2
B0
B1
B2
B3
OSC
BP
A2
B2
C2
D2
E2
F2
G2
A1
B1
C1
D1
E1
F1
G1
A4
B4
C4
D4
E4
F4
G4
A3
B3
C3
D3
E3
F3
G3
P1
P2
P3
BP1
BP2
41
25
29

Bear Medical Systems, Inc.

Bear

TITLE SCHEMATIC MONITOR PCB

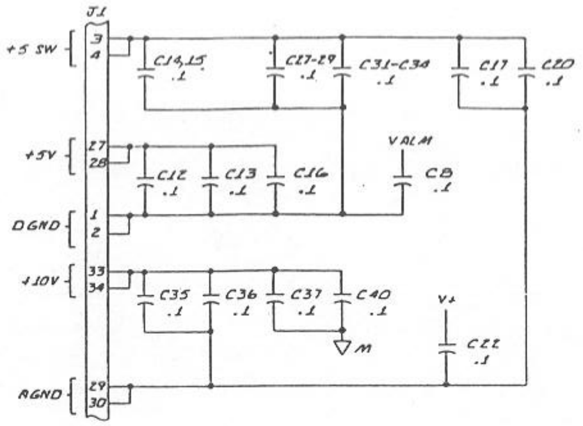
DRAWING NO. 54805-01808

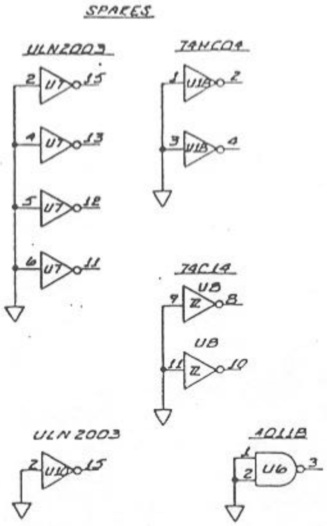
SCALE NONE

SHEET 4 OF 4

54805-01805

REVISIONS				
REV.	ECO NO.	DESCRIPTION	MADE BY	CHK'D BY
N/C	05858	PRODUCTION RELEASE	[illegible]	[illegible]
A	07306	R1 WAS: 1K (SHT 3 ZONE D-1)	[illegible]	[illegible]
B	07602	ADDED RG1. MOVED C23 NOTE 15 WAS 51000-08069.	[illegible]	[illegible]


J1
+5 SW
3
4
+5V
27
28
DGND
1
2
+10V
33
34
AGND
29
30
C14,15
.1
C27-29
.1
C31-C34
.1
C17
.1
C20
.1
C12
.1
C13
.1
C16
.1
VALM
C8
.1
C35
.1
C36
.1
C37
.1
C40
.1
M
V+
C22
.1


SPARES
ULN2003
2
U7
15
4
U7
13
5
U7
12
6
U7
11
74HC04
1
U18
2
3
U18
4
74C14
U8
9
8
U8
11
10
ULN 2003
2
U10
15
4011B
1
2
U6
3

REFERENCE DESIG	
LAST USED	NOT USED
C43	
CR25	
J1	
K1	
P4	
Q5	
RG1	
RN4	
TP1	
U27	
Y1	

I.C. TABLE

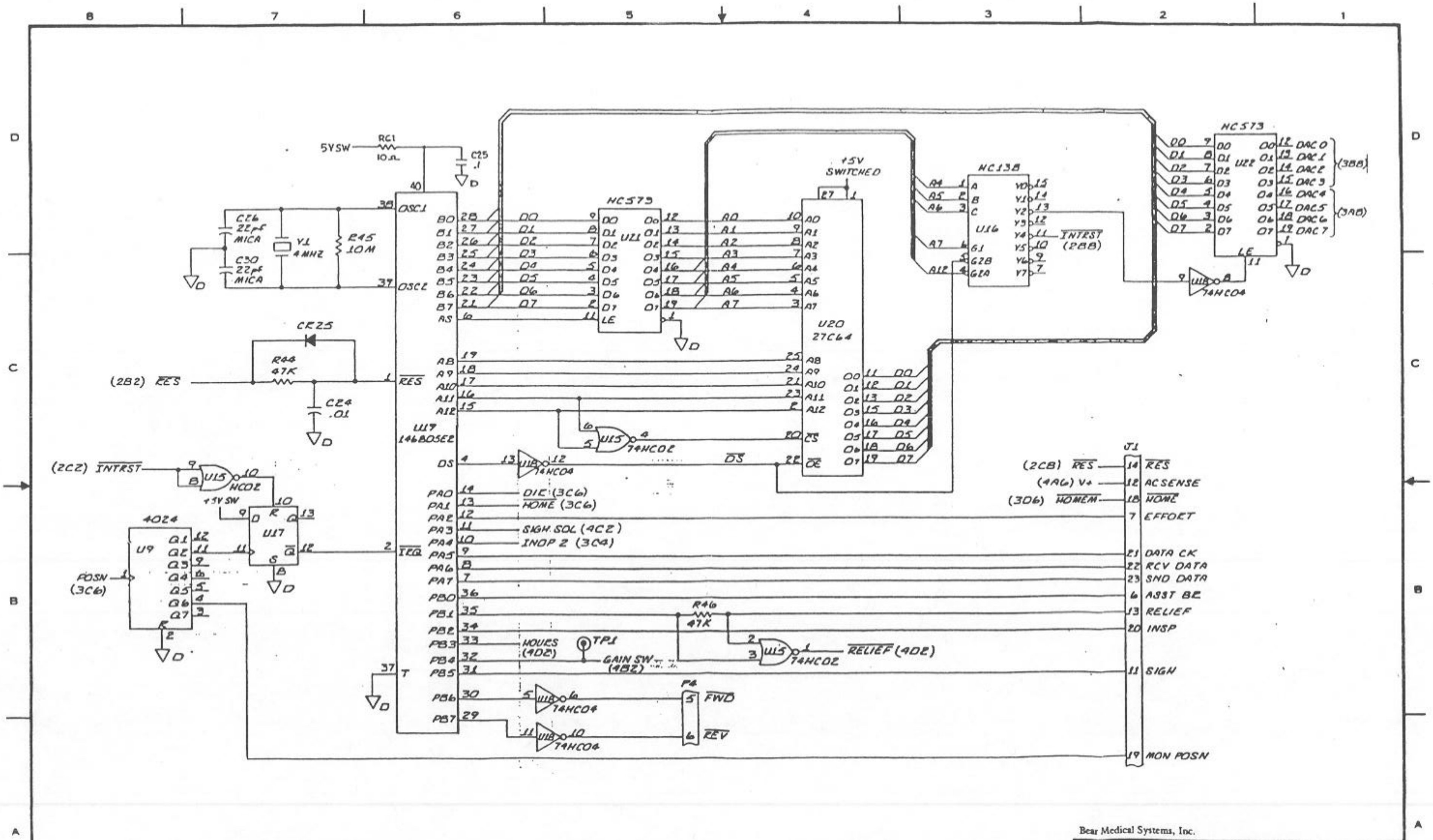
REF DESIG	TYPE	VOLTAGES					GROUND		
		+5V	+5SW	+10V	V+	+BUS SW	A	D	M
U1	7805	—	OUT	—	—	IN	—	GND	—
U2	LM317T	—	—	OUT	—	IN	—	—	—
U3	LM2931	OUT	—	—	—	—	—	GND	—
U4	74C14	—	—	—	—	—	—	7	—
U5,11	4001B	14	—	—	—	—	—	7	—
U6	4011B	14	—	—	—	—	—	7	—
U7,10,23	ULN2003	—	—	—	—	—	—	8	—
U8	74C14	—	14	—	—	—	—	7	—
U9	4024	—	14	—	—	—	—	7	—
U12	393	—	8	—	—	—	4	—	—
U13	393	—	—	—	—	—	4	—	—
U14	723	—	—	—	11,12	—	7	—	—
U15	74HC02	—	14	—	—	—	—	7	—
U16	HC138	—	16	—	—	—	—	8	—
U17	4013B	—	14	—	—	—	—	7	—
U18	74HC04	—	14	—	—	—	—	7	—
U19	146805E2	—	—	—	—	—	—	20	—
U20	27C64	—	26,28	—	—	—	—	14	—
U21,22	HC573	—	20	—	—	—	—	10	—
U24	7523	—	—	14	—	—	2,3	—	—
U25	358	—	—	8	—	—	—	—	4
U26	358	—	—	8	—	—	4	—	—
U27	3524	—	—	15	—	—	—	—	8

15. REF ASSEMBLY DWG 51000-08226
14. DIODES - TYPE 1N4148
13. CAPACITOR VALUES IN MFDS 10%
12. 1% TOLERANCE RESISTORS ARE TYPE RN55C
11. RESISTOR - VALUES IN OHMS 5% 1/4 W

Bear Medical Systems, Inc.

Bear

TITLE SCHEMATIC CONTROLLER PCB
DRAWING NO. 54805-01805
SCALE NONE
SHEET 1 OF 4



8
7
6
5
4
3
2
1
D
C
B
A
5YSW
RC1
10Ω
C25
.1
C26
22pf
MICA
C30
22pf
MICA
Y1
4MHZ
R45
10M
CR25
R44
47K
C24
.01
(2B2) RES
(2C2) INTRST
U15
HC02
+5V SW
U17
4024
U9
POSN
(3C6)
U17
146805E2
OSC1
OSC2
RES
IRQ
DS
HC573
U21
LE
U20
27C64
+5V
SWITCHED
CS
OE
HC138
U16
INTRST
(2B8)
HC573
U22
DAC0
DAC1
DAC2
DAC3
DAC4
DAC5
DAC6
DAC7
(3B8)
(3A8)
74HC04
74HC02
DIC (3C6)
HOME (3C6)
SIGH SOL (4C2)
INOP 2 (3C4)
HOURS
(4D2)
TP1
GAIN SW
(4B2)
R46
47K
RELIEF (4D2)
P4
FWD
REV
J1
(2C8) RES
(4A6) V+
(3D6) HOMEM
RES
AC SENSE
HOME
EFFORT
DATA CK
RCV DATA
SND DATA
ASST BE
RELIEF
INSP
SIGH
MON POSN

Bear Medical Systems, Inc.

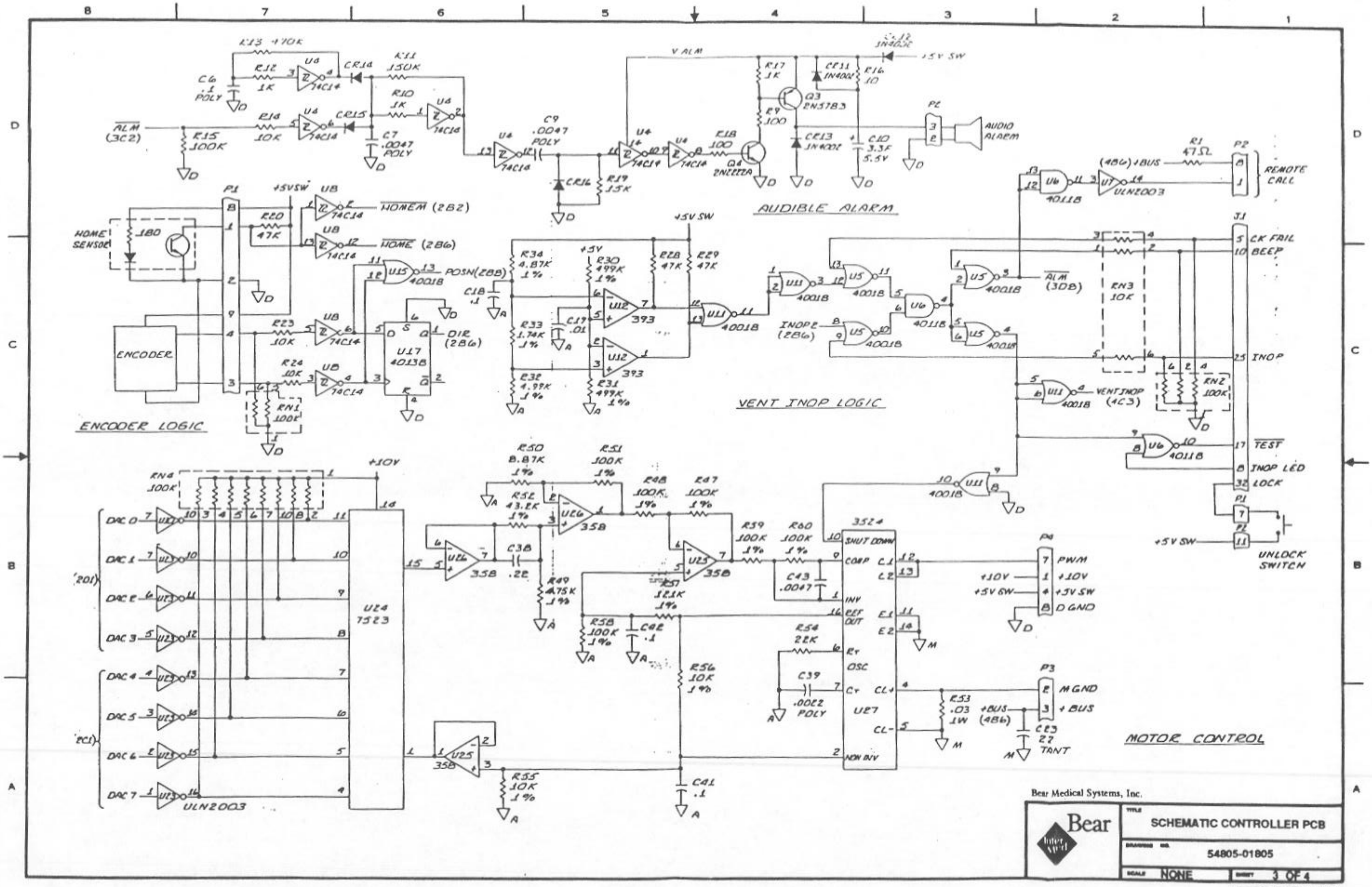
Bear InterMed

TITLE SCHEMATIC CONTROLLER PCB

DRAWING NO 54805-01805

SCALE NONE

SHEET 2 OF 4


AUDIBLE ALARM
ENCODER LOGIC
VENT INOP LOGIC
MOTOR CONTROL
HOME SENSOR
ENCODER
AUDIO ALARM
REMOTE CALL
UNLOCK SWITCH
J1
P1
P2
P3
P4
5 CK FAIL
10 BEEP
25 INOP
17 TEST
8 INOP LED
32 LOCK
7 PWM
1 +10V
4 +5V SW
8 D GND
2 M GND
3 + BUS
ALM (3C2)
ALM (3D8)
HOMEM (2B2)
HOME (2B6)
POSN(2B8)
DIR (2B6)
INOP2 (2B6)
VENT INOP (4C3)
(4B6) +BUS
V ALM
+5V SW
+10V
U24 7523
U27 3524
U17 4013B
U12 393
U25 358
U26 358
ULN2003
40018
40118
74C14
DAC 0
DAC 1
DAC 2
DAC 3
DAC 4
DAC 5
DAC 6
DAC 7
SHUT DOWN
COMP
INV
REF OUT
OSC
NON INV
RN1 100K
RN2 100K
RN3 10K
RN4 100K
R1 47Ω
Q3 2N5783
Q4 2N2222A
C10 3.3F 5.5V
C23 22 TANT
R53 .03 1W

Bear Medical Systems, Inc.

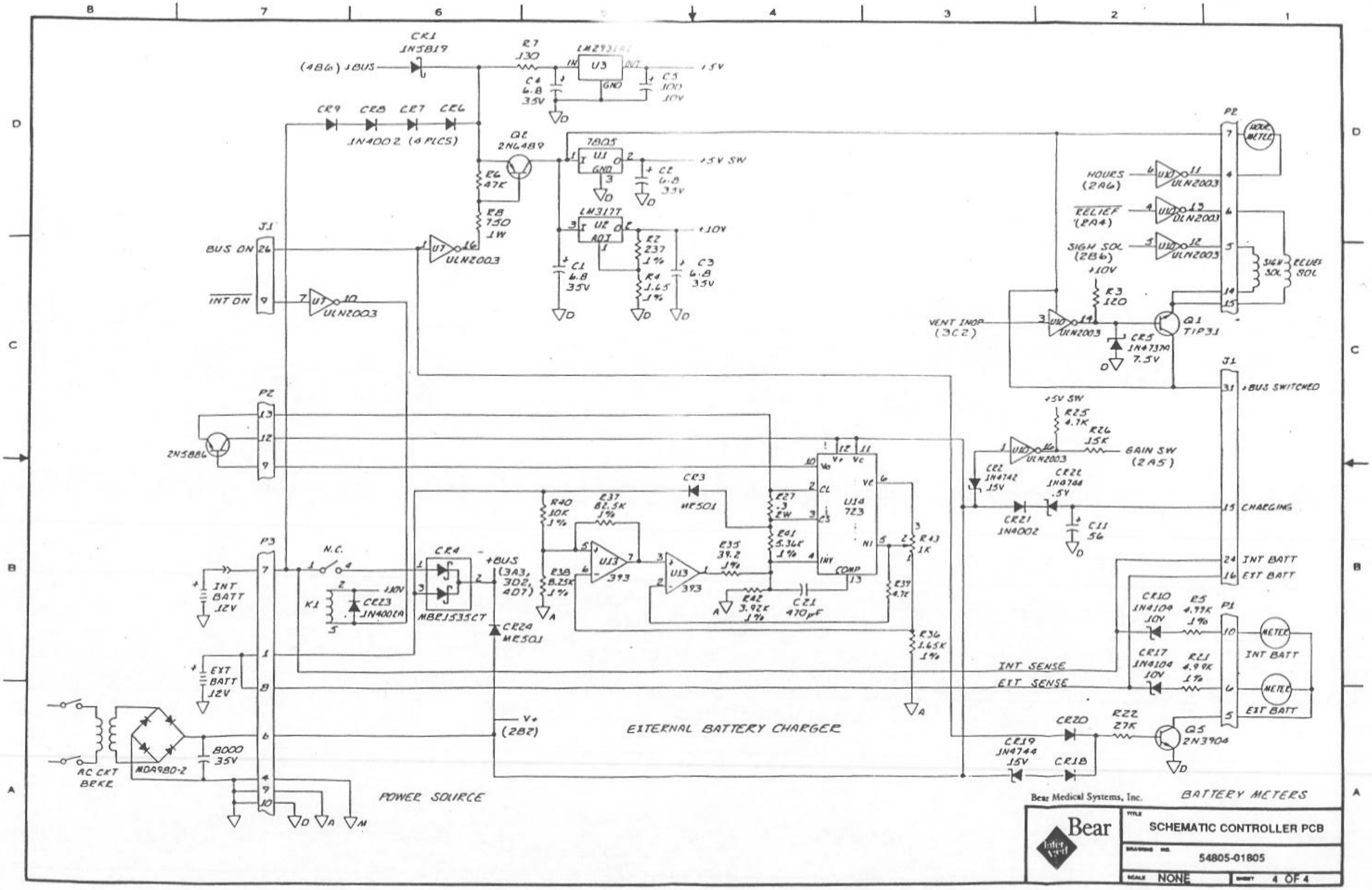
Bear

SCHEMATIC CONTROLLER PCB

54805-01805

NONE

3 OF 4


(4B6) +BUS
CR1
1N5819
R7
130
LM2931AZ
U3
IN
OUT
GND
+5V
C4
6.8
35V
C5
100
10V
CR9
CR8
CR7
CR6
1N4002 (4 PLCS)
Q2
2N6489
R6
47K
R8
750
1W
7805
U1
GND
+5V SW
C2
6.8
35V
LM317T
U2
ADJ
+10V
C1
6.8
35V
R2
237
1%
R4
1.65
1%
C3
6.8
35V
J1
BUS ON
INT ON
U7
ULN2003
P2
2N5886
P3
N.C.
K1
CR23
1N4002A
+10V
CR4
MBE1535CT
+BUS
(3A3, 3D2, 4D7)
CR24
MES01
V+
(2B2)
INT BATT
12V
EXT BATT
12V
AC CKT
BRKR
MDA980-2
8000
35V
POWER SOURCE
R40
10K
1%
R37
82.5K
1%
R38
8.25K
1%
U13
393
CR3
MES01
R35
39.2
1%
R42
3.92K
1%
R27
.3
2W
R41
5.36K
1%
C21
470pF
U14
723
V+
VC
VO
CL
CS
INV
NI
VR
COMP
R43
1K
R37
4.7K
R36
1.65K
1%
EXTERNAL BATTERY CHARGER
INT SENSE
EXT SENSE
HOURS
(2A6)
RELIEF
(2A4)
SIGH SOL
(2B6)
U10
ULN2003
+10V
R3
120
VENT INOP
(3C2)
CR5
1N4737A
7.5V
Q1
TIP31
HOUR METER
SIGH SOL
RELIEF SOL
+BUS SWITCHED
+5V SW
R25
4.7K
R26
15K
GAIN SW
(2A5)
CR2
1N4742
15V
CR22
1N4744
.5V
CR21
1N4002
C11
56
CHARGING
INT BATT
EXT BATT
CR10
1N4104
10V
R5
4.99K
1%
CR17
1N4104
10V
R21
4.99K
1%
P1
METER
CR20
R22
27K
Q5
2N3904
CR19
1N4744
15V
CR18
BATTERY METERS
A
B
C
D
1
2
3
4
5
6
7
8

Bear Medical Systems, Inc.

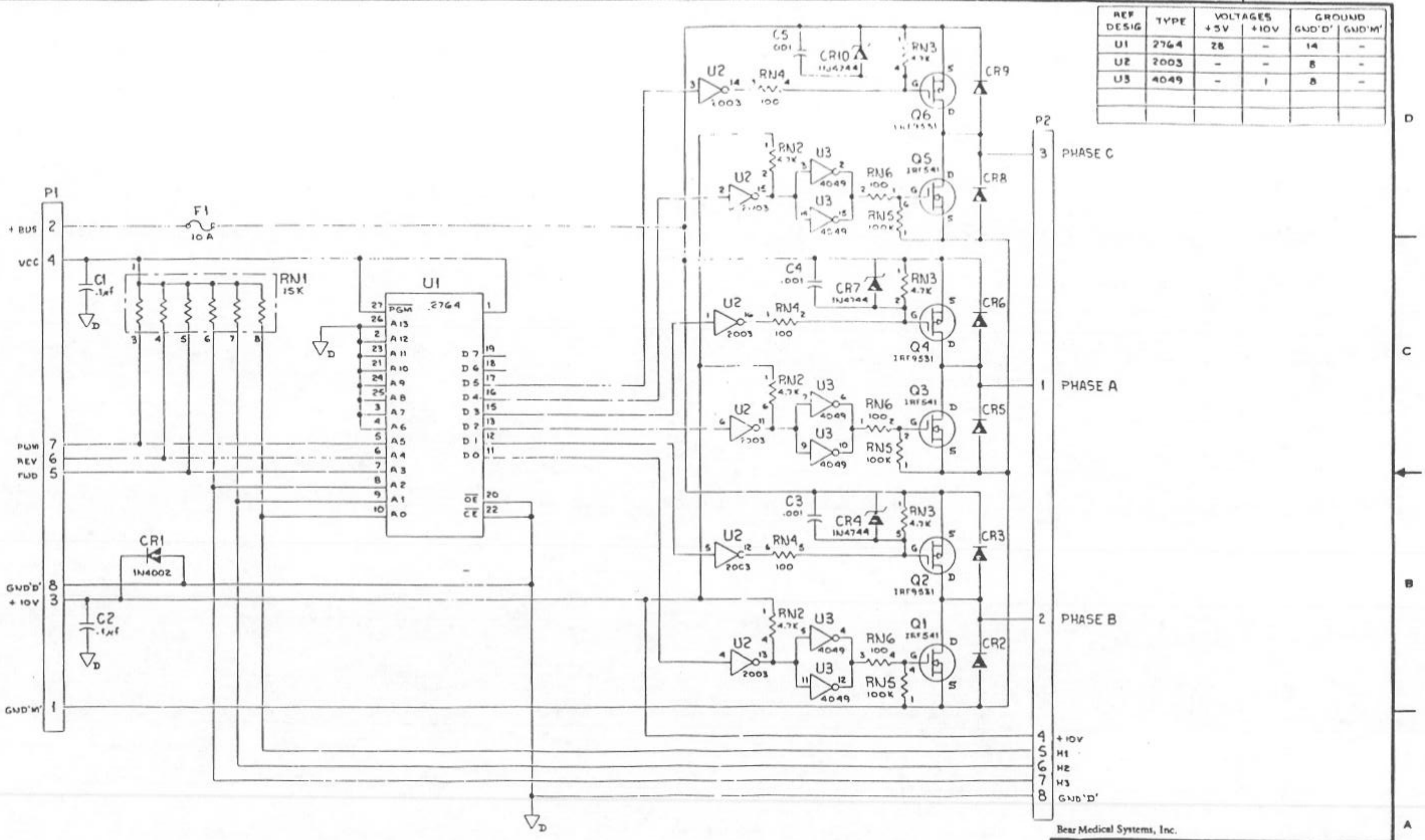
Bear

TITLE SCHEMATIC CONTROLLER PCB

DRAWING NO. 54805-01805

SCALE NONE

SHEET 4 OF 4


P1
+BUS 2
VCC 4
PWM 7
REV 6
FWD 5
GND'D' 8
+10V 3
GND'M' 1
F1
10 A
C1
.1µf
C2
.1µf
CR1
1N4002
RN1
15K
U1
2764
PGM
A13
A12
A11
A10
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
D7
D6
D5
D4
D3
D2
D1
D0
OE
CE
U2
2003
U3
4049
RN2
4.7K
RN3
4.7K
RN4
100
RN5
100K
RN6
100
C3
.001
C4
.001
C5
.001
CR4
1N4744
CR7
1N4744
CR10
1N4744
Q1
IRF541
Q2
IRF9531
Q3
IRF541
Q4
IRF9531
Q5
IRF541
Q6
IRF9531
CR2
CR3
CR5
CR6
CR8
CR9
P2
3 PHASE C
1 PHASE A
2 PHASE B
4 +10V
5 H1
6 H2
7 H3
8 GND'D'
D
8
7
6
5
4
3
2
1
D
C
B
A

REF DESIG	TYPE	VOLTAGES		GROUND	
		+5V	+10V	GND'D'	GND'M'
U1	2764	28	–	14	–
U2	2003	–	–	8	–
U3	4049	–	1	8	–

Bear Medical Systems, Inc.

Bear

TITLE SCHEMATIC MOTOR PCB

DRAWING NO. 54805-01805

SCALE NONE

SHEET 1 OF 1

SECTION 7
BEAR® 33 VOLUME VENTILATOR TROUBLESHOOTING

INTRODUCTION

The information in this section is intended for use by a Bear Medical Systems, Inc., factory trained service technician or biomedical engineer. Before diagnosing a problem using the troubleshooting information contained in this section, a reference should be made to the Instruction Manual to assure that the ventilator is being utilized properly.

This section is NOT intended to replace the skills and knowledge of a trained field engineer, but should only serve to expedite the repair of the ventilator.

USER INTERFACE

A review of user interface with equipment is the first step in a typical troubleshooting progression. Failure to analyze data properly in this step usually results in a failure to repair the equipment and could cost valuable data, time and possible equipment damage. Isolation of operator error or operator assisted malfunction from actual equipment malfunction is essential. Through past experience, we have solved a large percentage of alleged equipment malfunctions in this stage.

Complete understanding of the Instruction Manual is mandatory before data can be accumulated and analyzed.

TROUBLESHOOTING ANALYSIS

This process is used only after the problem has been determined not to be userinterface of calibration (Section 5). The Operational Verification Procedure (Section 3) should be completed to the highest possible level and the data logged before any attempt is made to isolate the problem.

WARNINGS

The following warnings must be read and understood before performing any of the procedures described in this section.

- Under no circumstances should this medical device be operated in the presence of flammable anesthetics or other volatile materials due to a possible explosion hazard.
- Liquid spilled or dripped into the unit may cause damage to the unit or result in an electrical shock hazard.
- Oxygen vigorously accelerates combustion. Do not use any gauges, valves or other equipment that have been exposed to oil or grease contamination to avoid violent ignition.
- When verifying the operation of this medical device, do not breathe directly from the machine. Always use a fresh bacterial filter and test circuit. A hazard to the health of the service person may result.
- Do not release this medical device if any alarm/alert function is inoperative. To do so could result in a malfunction without warning, possibly resulting in personal injury or death and/or property damage. Refer the unit to a Bear Medical Systems authorized service technician or a Bear Medical Systems trained hospital service technician.
- Hazardous voltages exist within this medical device. Always observe appropriate safety precautions when working on the unit while the machine is connected to an electrical power source to prevent possible accidental injurious electrical shock.
- This medical device should never be serviced or the covers removed when connected to a patient. Internal maintenance may affect the operation of the unit, jeopardizing patient care.

WARNINGS, continued

- Disconnect all electrical power, air and oxygen sources before attempting any disassembly. Failure to do so could result in injury to the service technician and/or damage to the equipment

- Do not dispose of the internal sealed lead acid battery by incineration as it may explode when exposed to flame.

- Do not allow the battery charger to be exposed to fluids. If it becomes wet, it may cause an electrical hazard.

- Use extreme care when soldering to prevent solder splashes, damage to connectors, solder bridges (solder connections between two terminal points or to ground), or possible short circuits due to burned wire insulation. Any of these conditions could cause ventilator failure, resulting in possible injury or death, to the patient.

- Do not use TEFLON™ tape in place of pipe sealant. Sharp threads may shred the tape and the fibers could possibly clog critical orifices, resulting in possible patient injury or death.

- The verification and/or calibration procedures contained in Section 5 must be completed when any part/assembly has been removed and/or replaced. Failure to do so could result in malfunction of this medical device and/or injury to the patient.

- Do not attempt to charge the internal battery with any other charger than the one contained in the ventilator, as the battery may explode or become damaged.

CAUTIONS

The following cautions must be read and understood before performing any of the procedures described in this section.

- *If any of the following procedures cannot be verified as outlined in this document, disconnect the ventilator and refer it to Bear Medical Systems or a Bear Medical Systems authorized service facility or a Bear Medical Systems trained hospital service technician.*

- *Do not use MEK or Tricloroethylene, as damage to surfaces may result, Do not allow any liquid to spill or drip into the ventilator.*

- *Do not gas sterilize the ventilator, as the internal materials are not compatible with gas sterilization techniques.*

- *Before using any test equipment (electronic or pneumatic) for calibration procedures (other than operational verification), the accuracy of the instruments must be certified by a testing laboratory. The laboratory master test instruments must be traceable to the US Bureau of Standards or equivalent. When variances exist between the indicated and actual values, the calibration curves (provided for each instrument by the testing laboratory) must be used to establish the actual correct values. This certification procedures should be performed at least once every six months. More frequent certification may be required based on usage and environment.*

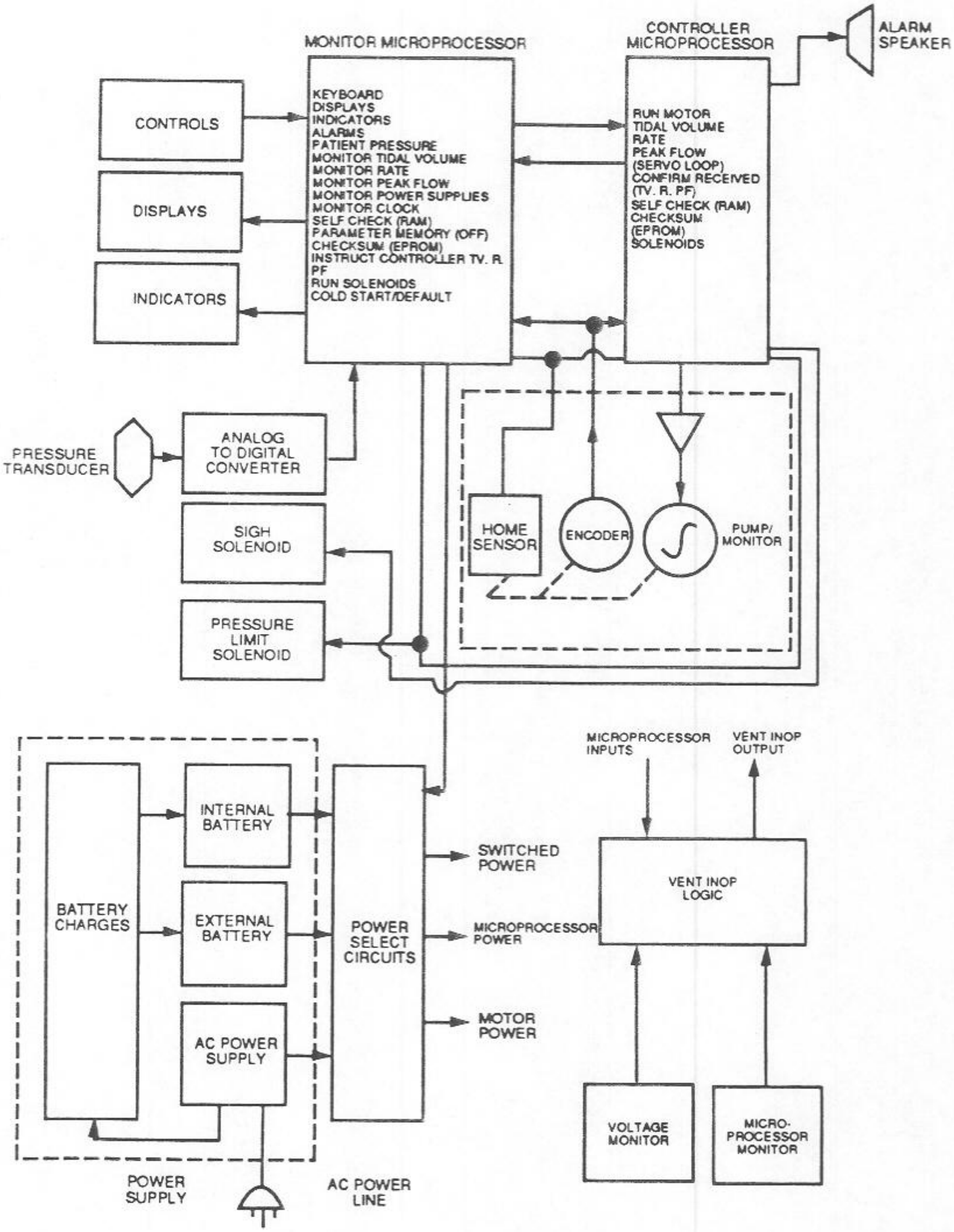

MONITOR MICROPROCESSOR
CONTROLLER MICROPROCESSOR
ALARM SPEAKER
CONTROLS
DISPLAYS
INDICATORS
KEYBOARD
DISPLAYS
INDICATORS
ALARMS
PATIENT PRESSURE
MONITOR TIDAL VOLUME
MONITOR RATE
MONITOR PEAK FLOW
MONITOR POWER SUPPLIES
MONITOR CLOCK
SELF CHECK (RAM)
PARAMETER MEMORY (OFF)
CHECKSUM (EPROM)
INSTRUCT CONTROLLER TV. R. PF
RUN SOLENOIDS
COLD START/DEFAULT
RUN MOTOR
TIDAL VOLUME
RATE
PEAK FLOW
(SERVO LOOP)
CONFIRM RECEIVED
(TV. R. PF)
SELF CHECK (RAM)
CHECKSUM
(EPROM)
SOLENOIDS
PRESSURE TRANSDUCER
ANALOG TO DIGITAL CONVERTER
SIGH SOLENOID
PRESSURE LIMIT SOLENOID
HOME SENSOR
ENCODER
PUMP/ MONITOR
BATTERY CHARGES
INTERNAL BATTERY
EXTERNAL BATTERY
AC POWER SUPPLY
POWER SELECT CIRCUITS
SWITCHED POWER
MICROPROCESSOR POWER
MOTOR POWER
POWER SUPPLY
AC POWER LINE
MICROPROCESSOR INPUTS
VENT INOP OUTPUT
VENT INOP LOGIC
VOLTAGE MONITOR
MICRO-PROCESSOR MONITOR

Figure 7-1
ELECTRONIC BLOCK DIAGRAM

99

NOTE

Thoroughly review the Instruction Manual and Section 2 of this maintenance manual before proceeding with any repair.

NOTE

If following this chart does not locate the problem prform a complete verification as described in Section 5.

Table 7-1
Power Supply Troubleshooting

Symptom	Possible Causes	Test
Unit completely dead	1. Monitor PCB problem	a. Monitor Microprocessor Test (Sec 5) b. Controller Microprocessor Test (Sec 5)
	2. Defective charging circuit and dead internal battery.	a. Test battery b. Test charging circuit (Sec 5) c. Test bridge rectifier, power transformer, main filter capacitor and circuit breaker
Unit works on internal or external battery but not with AC power line	1. Defective AC power supply	a. Test +5V and switched +5V b. Test all power supply reference voltages c. Test bridge rectifier, power transformer, main filter capacitor and circuit breaker
Unit works on AC power, but not on internal battery	1. Charging circuit malfunction 2. Defective battery	a. Test battery charging circuit b. Replace internal battery

NOTE

A defective monitor PCB can appear to be a power supply problem. Displays may be blank and the Controller PCB may also be inactivated, disabling motor control circuits.

Table 7-2
Rate Troubleshooting

Symptom	Test	Action
Rate (BPM) is different from value entered on Rate display	1. Perform Rate Test in OVP 2. Perform Pump Module Test (Sec 7) 3. Verify Control PCB Microprocessor activity. Perform Control PCB Microprocesor generated Clock Signal Test (Sec 7) 4. Perform Heartbeat Test (Sec 7). Problem may be on Controller PCB.	a. Verify problem b. If pump module problem, replace defective component (See Pump Module Test, Sec 7)
	1. Refer to OVP previously run; was RATE the only function that could not be set from the front panel? 2. If RATE was only inactive function, problem may be in RATE membrane switch or on Monitor PCB 3. If there are other inactive controls, Monitor PCB is more likely problem.	a. Replace defective PCB

Table 7-3
Volume Troubleshooting

Symptom	Test	Action
Measured Volume is different from value entered on Volume display	1. Perform Delivered Volume Test in OVP 2. Perform Pump Module Test (Sec 7) 3. Perform Heartbeat Test (Sec 7). Problem may be on Controller PCB.	a. Verify problem b. If pump module problem, replace defective component (See Motor Current Test, Sec 7)
Volume cannot be adjusted from front panel	1. Refer to OVP previously run; was VOLUME the only function that could not be set from the front panel? 2. If VOLUME was only inactive function, problem may be in RATE membrane switch or on Monitor PCB 3. If there are other inactive controls, Monitor PCB is more likely problem.	a. Replace defective PCB

Table 7-4
Alarm Troubleshooting

Symptom	Test	Action
LOW PRESS or HIGHPRESS alarm problem	1. Perform Transducer and Zero Midrange verification procedures (Sec 5). If transducer cannot be calibrated to specifications, problem is probably a transducer or Monitor PCB malfunction	a. Replace Monitor PCB
Vent INOPAlarm activated All other alarm problems	1. Perform all power supply verification tests (Sec 5). See Power Supply Troubleshooting Chart	a. Calibrate Power Supply voltages if possible. If not, replace Controller PCB
	2. Test battery charge if VENT INOPon internal battery only	a. Charge or replace internal battery
	3. Perform Heartbeat Test (Sec 7). Problem may be on Controller PCB.	a. If clock signal is OK on Controller PCB, replace Monitor PCB b. If clock signal is not OK on Controller PCB, replace Controller PCB
	1. If audible alarm problem only, test alarm speaker before replacing Monitor PCB	a. Replace Monitor PCB

Home Sensor Test

1. Turn the unit off.
2. Connect a DVM between P1, Pin 1 and the negative terminal of the internal battery.
3. While observing the meter, turn the unit on.
4. Verify that at power-on, the voltage is +0.8VDC or less.
5. Verify that when the piston moves fully forward, the meter reads +4.0 to 5.0 VDC.
6. When the piston retracts, verify that the voltage again reads +0.8 VDC or less.

If the test fails, the Sensor PCB is probably defective and must be replaced.

If the motor and optical encoder tests do not meet specification, a replacement Controller PCB is indicated. Replace the defective assembly. Perform the Verification/Calibration procedure described in Section 5. Always perform a final OVP prior to returning the unit to normal use.

Heartbeat Detector Test

This test verifies the existence of the master clock signal on the Monitor PCB. If the clock signal is not there, the Heartbeat Detector should respond with a VENT INOP. The master clock signal originates on the Controller PCB so if it is missing on the Monitor PCB, the source should be checked on the Controller PCB. The test point for the master clock signal on the Controller PCB is J1, Pin 21 (DATA CLK).

Procedure

1. Connect an oscilloscope or logic probe to TP5 on the Monitor PCB and ground.
2. Verify that TP5 is logic HIGH and no logic transitions are occurring.
3. Connect the probe to TP3 on the Monitor PCB.
4. Verify that TP3 is logic LOW and no logic transitions are occurring.

A continuous logic HIGH on TP3 or continuous logic LOW on TP5, or both, indicates a problem on either the Monitor or Controller PCBs. Perform the power supply verifications in Section 5, since a power supply problem can also cause this test to fail.

Motor Current Test

1. Set the ventilator controls to the following:
   TIDAL VOLUME = 800 ml
   BREATH RATE = 17 BPM
   PEAK FLOW = 100 LPM
   PEAK INSP PRESSURE = 60 ±5 cmH2O

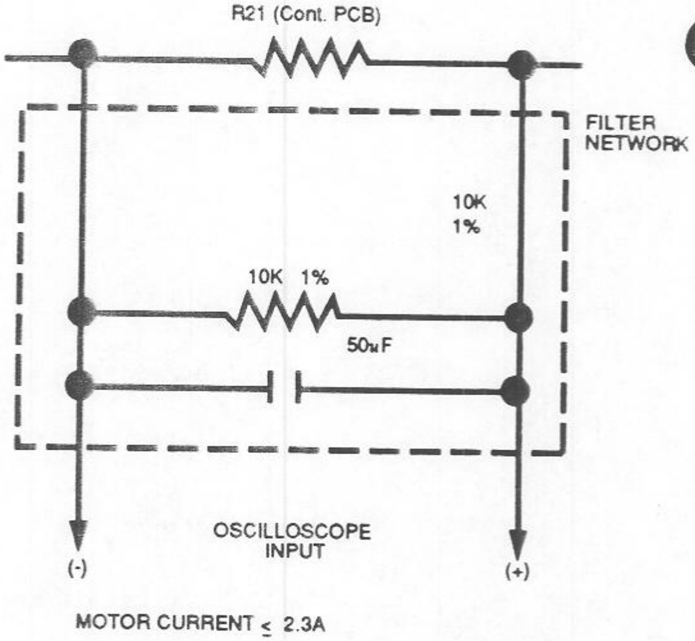


Figure 7-2
MOTOR CURRENT MEASUREMENT TEST CIRCUIT

NOTE
Two types of Controller PCBs have been used. The earlier type is P/N 51000-08069; the later type is P/N 51000-08226. The type of PCB will influence the position of the components and the calculations.

2. Turn the unit off.
3. Disconnect the internal battery positive lead.
4. Connect the unit to a variable AC power supply.
5. Connect the DVM to the positive side of C2/C4 and ground on the Controller PCB.
6. Connect the external filter across R21/R53, noting that the "–" oscilloscope input is connected to the lower leg of the resistor.
7. Connect the oscilloscope to the test circuit.
8. Turn the unit on, and adjust the variable power supply until a reading of +21.0 ±0.1 VDC is obtained during the idle phase of the pump.
9. Measure the voltage drop while the unit is cycling and calculate the motor current.

The motor current should not exceed 2.3A on the inspiratory stroke. If it does so, check the drive belt for wear and proper tension (Section 8). Excessive current indicates probably mechanical problems in the pump module assembly.

SECTION 8
BEAR® 33 VOLUME VENTILATOR REMOVAL AND REPLACEMENT PROCEDURES

Be sure to observe all warnings and cautions listed on pages i-iii, i-iv, and i-v.

CAUTION

Before performing any procedure in this section, disconnect the positive (+) lead on the internal battery to avoid possible damage to the ventilator.

WARNING

The Operational Verification Procedures in Section 3 and Calibration Procedures in Section 5 must be completed when any part or assembly has been removed and/or replaced. Failure to do so could result in malfunction of this medical device and/or injury or death to the patient.

Bridge Rectifier

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove wire #38 and wire #37 from the bridge rectifier: wire #38(+) from the top terminal and wires #37(-) from the bottom terminal. Remove both of the red leads on either side.
4. Remove the hex nut and lockwasher that secure the bridge rectifier, via the threaded stud, to the side of the internal battery housing.
5. Remove the bridge rectifier.

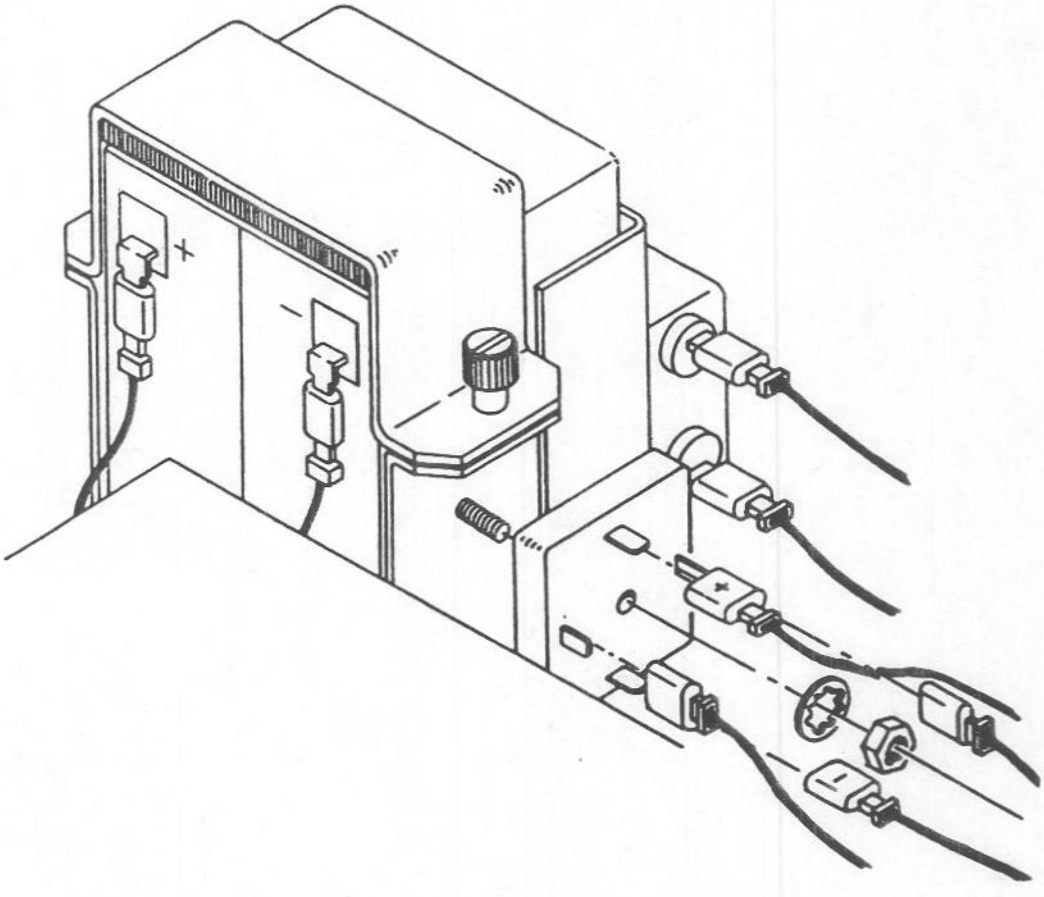


Figure 8-1
BRIDGE RECTIFIER

Replacement Procedure

1. Position the replacement bridge rectifier so that the "+" terminal is at 12 o'clock.
2. The balance of the replacement procedure can be accomplished by reversing the removal procedure.

Internal Battery

Removal Procedure

1. Remove the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Using an ordinary screwdriver, loosen the two captive screws securing the battery cover.
4. Lift off the battery cover and set it aside.
5. Remove the two quick-disconnect terminals and lift the battery out of its compartment. Be sure that the battery cushions remain in place.

Replacement Procedure

The replacement procedure is accomplished by reversing the removal procedure.

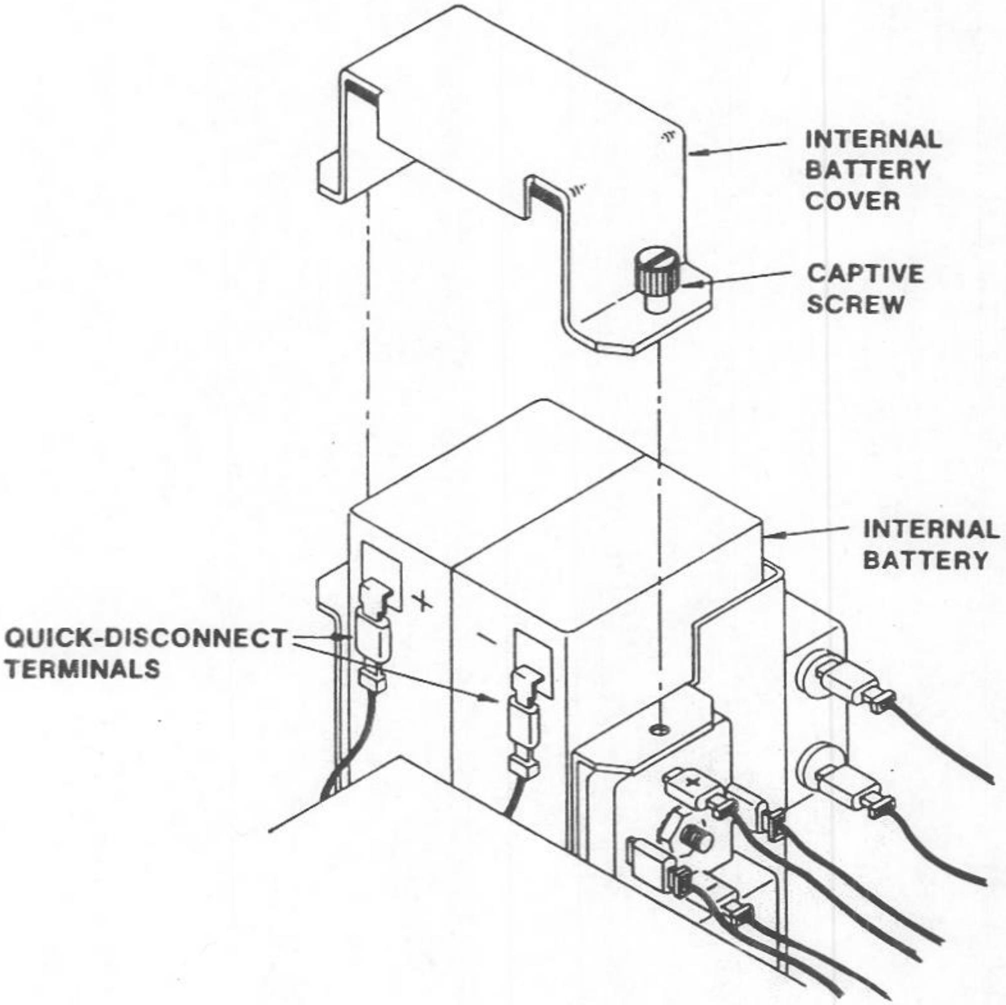

INTERNAL BATTERY COVER
CAPTIVE SCREW
INTERNAL BATTERY
QUICK-DISCONNECT TERMINALS
+
−

Figure 8-2
INTERNAL BATTERY

Circuit Breaker

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove the two quick-disconnect terminals from the circuit breaker.
4. Place masking tape over the serrations on each jaw of pliers to prevent damage to the ventilator panel or mounting nut.
5. Remove the circuit breaker mounting nut.
6. Remove the circuit breaker from the panel. Set it and the mounting nut aside.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.

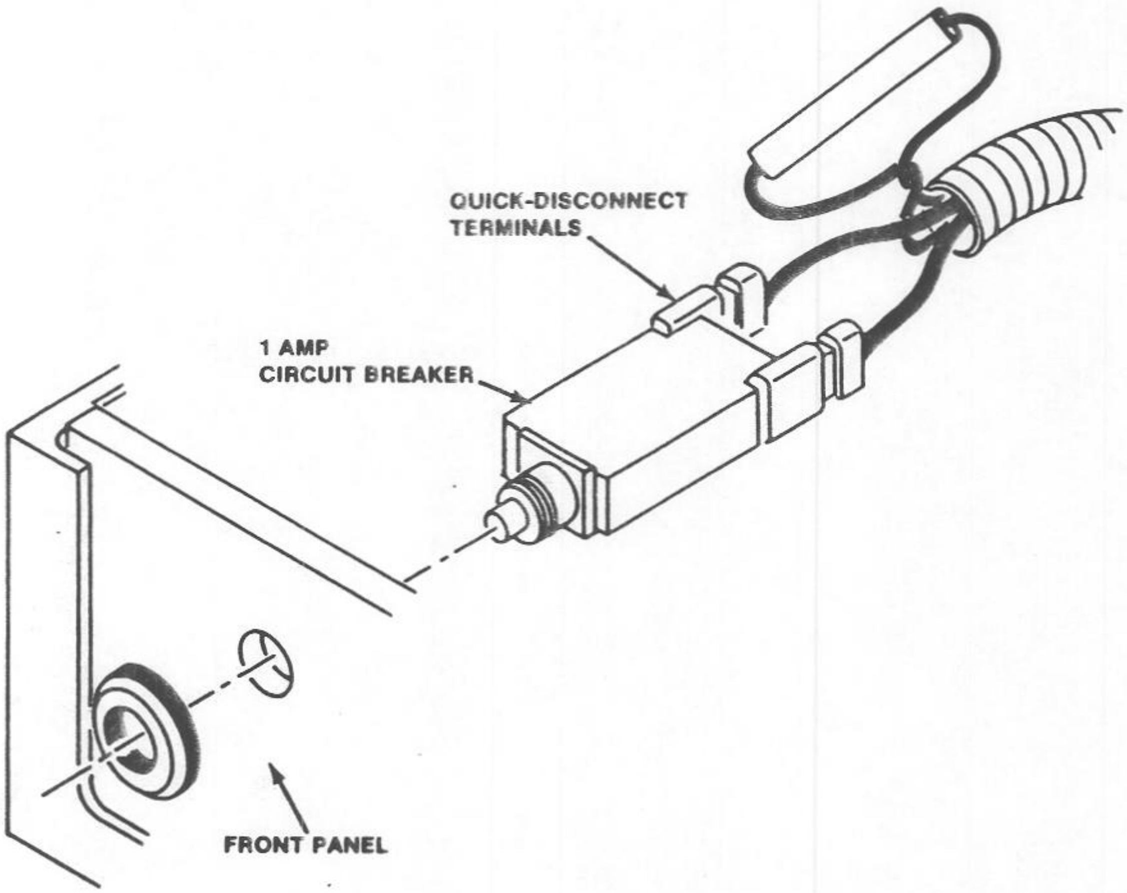


Figure 8-3
CIRCUIT BREAKER

105

Filter Capacitor

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove Pump Module Assembly (see Section 8).
4. Observing connection polarity, remove the ring-terminal wires connected to the capacitor screws. Push these wires aside to clear the capacitor.
5. Slide the capacitor free of its retaining bracket.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.

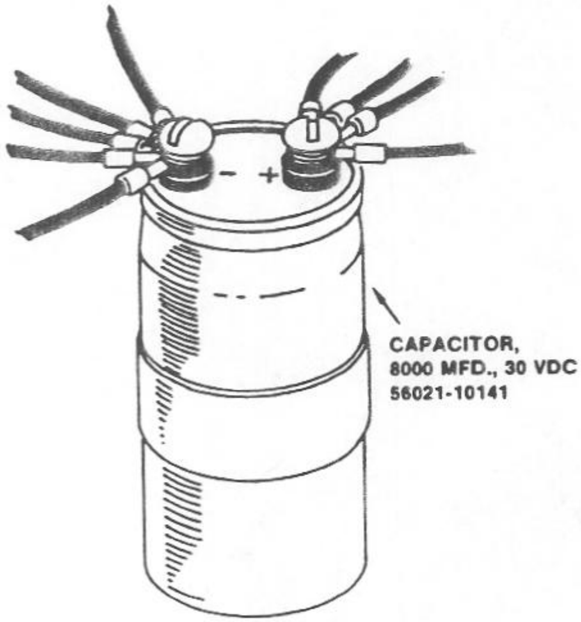


Figure 8-4
FILTER CAPACITOR

Power Transformer

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4)
3. Cut the cable tie secure the Controller PCB Cable Harness and the Circuit Breaker Cable Harness to the Internal Battery housing.
4. Remove the circuit breaker mounting nut, pull the circuit breaker wire harness at the Molex connector. Set the circuit breaker and its wire harness to one side.
5. Disconnect the two red leads from the bridge rectifier and feed them through the harness to free the transformer.
6. Route the transformer and the Controller PCB wire harness to clear the power transformer mounting screws.
7. Remove the four mounting screws and life out the transformer.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.

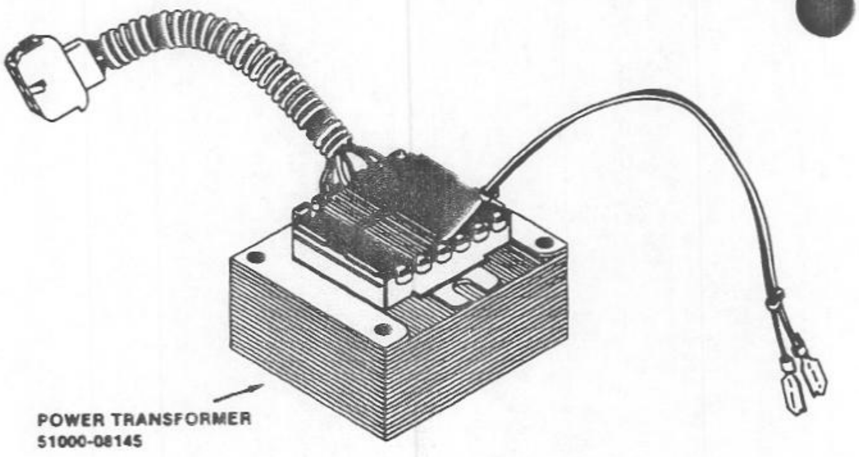


Figure 8-5
POWER TRANSFORMER

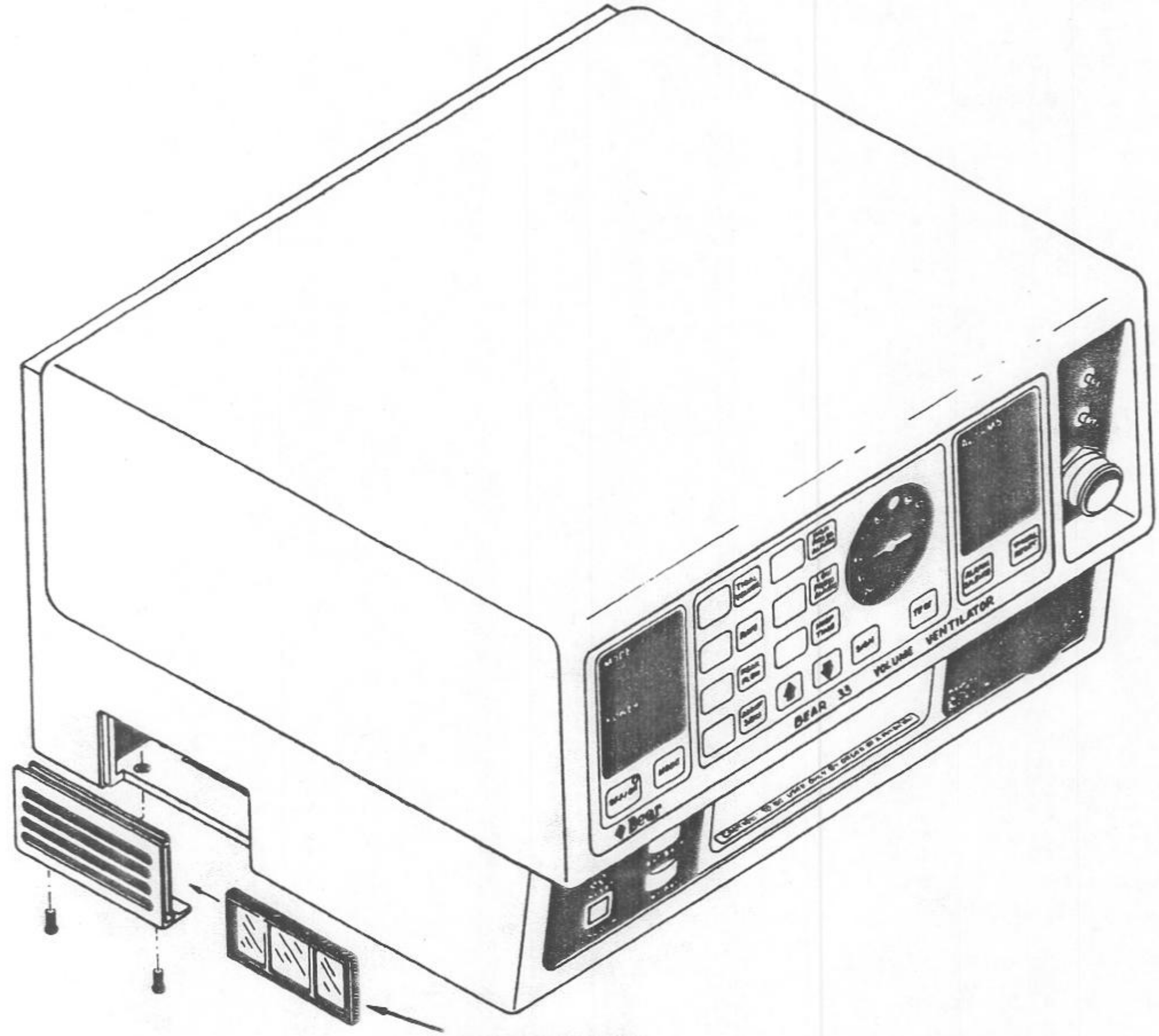
Case Vent Filter

Removal Procedure

1. Remove all tubing connected to the ventilator.
2. Position the ventilator to access and remove the two screws on the left side of the ventilator base.
3. Slide the flush mounter filter retainer door away from the ventilator housing.
4. Remove the filter from the slot in the filter retainer door.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.



CASE VENT FILTER
51000-08121

Figure 8-6
CASE VENT FILTER

Drive Belt

Removal Procedure

1. Remove the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Loosen the four motor mount screws. Slide the motor toward the drive pulley.
4. Slip the belt to be replaced off the motor pulley and drive pulley.

Replacement Procedure

1. Install the new belt on the motor pulley and the drive pulley.
2. Slide the motor back to its original position.
3. Tighten the motor mount screws slightly, just enough to hold the motor.
4. Position the belt tension tool (P/N 51000-08239) on top of drive pulley.
5. While holding the spring latch down, position the tool under motor mounting flange. Make sure the tool is seated on both the pulleys and the belt.
6. Slide the motor back until the belt brings the pointer up and aligns with the top mark on the tool.
7. Retighten the motor mount screws that are accessible with the tool in position.
8. Remove the tool and tighten the remaining screws.
9. Torque to 8 3/4 inch pounds.
10. Replace the unit cover.

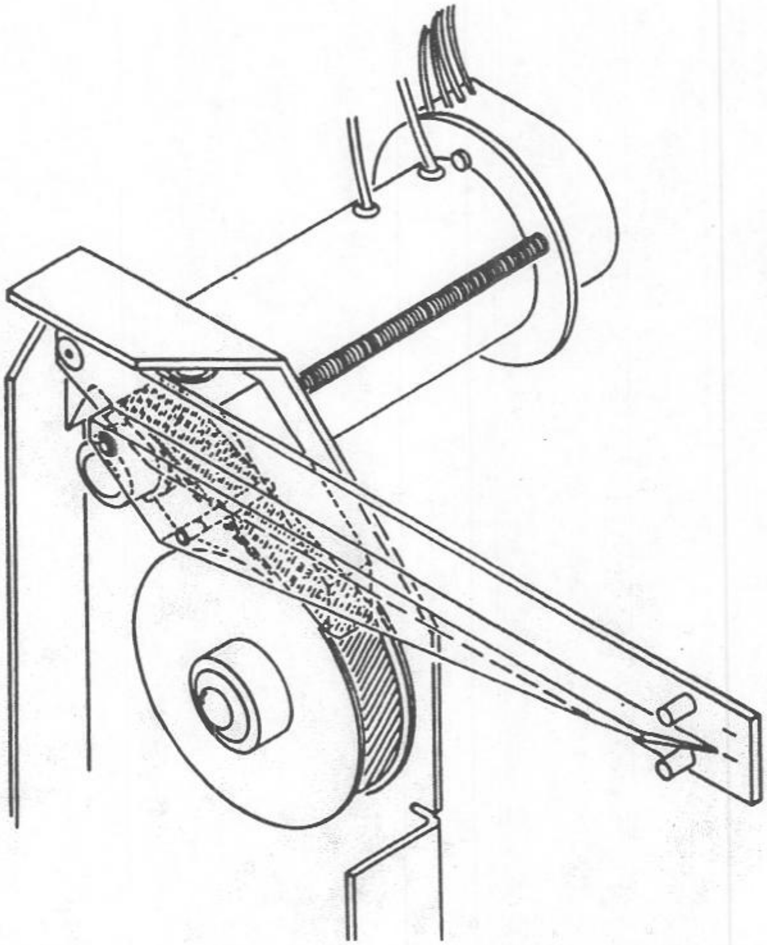


Figure 8-7
DRIVE BELT

108

Patient Air Inlet Filter

Removal Procedure

1. Using an ordinary screwdriver, loosen the camlock screw on the inlet filter door. The camlock screw is captive.
2. Grasp the inlet port cover, pull the door free and set it aside.
3. Remove the air inlet filter by gently pulling it out of its pressfit recess.

Replacement Procedure

After cleaning the original filter or substituting a new unit, replacement may be accomplished by reversing the removal procedure.

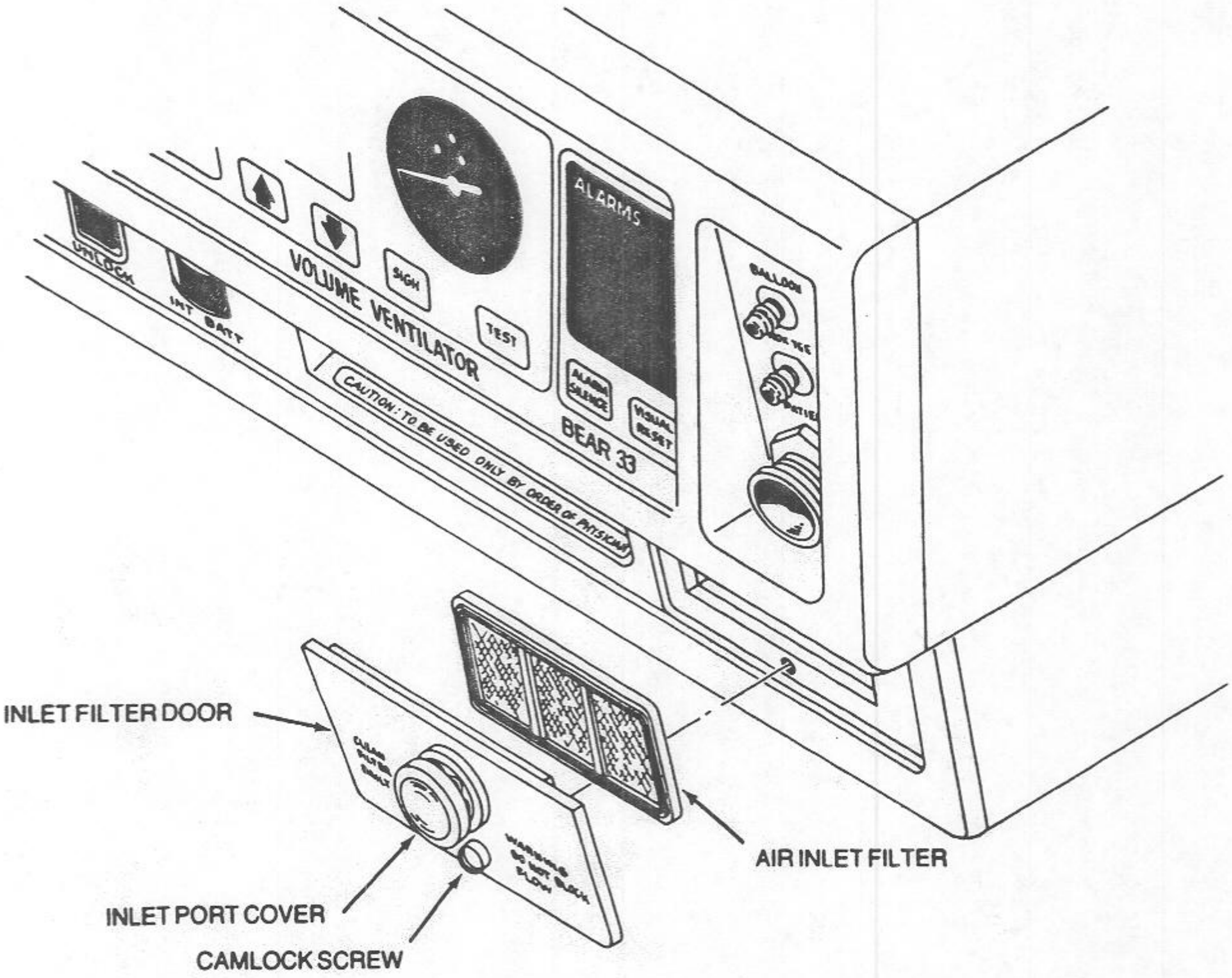

UNLOCK
INT BATT
VOLUME VENTILATOR
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
BEAR 33
CAUTION: TO BE USED ONLY BY ORDER OF PHYSICIAN
BALLOON
CLEAN FILTER DAILY
WARNING DO NOT BLOCK FLOW
INLET FILTER DOOR
AIR INLET FILTER
INLET PORT COVER
CAMLOCK SCREW

Figure 8-8
PATIENT AIR INLET FILTER

Alarm Speaker

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove two retainer nuts and two speaker retainers.
4. Position PVC tubing to access speaker. Slide speaker off threaded studs. Set aside the gaskets and speaker screen.
5. Turn speaker to access terminals and unsolder wires.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

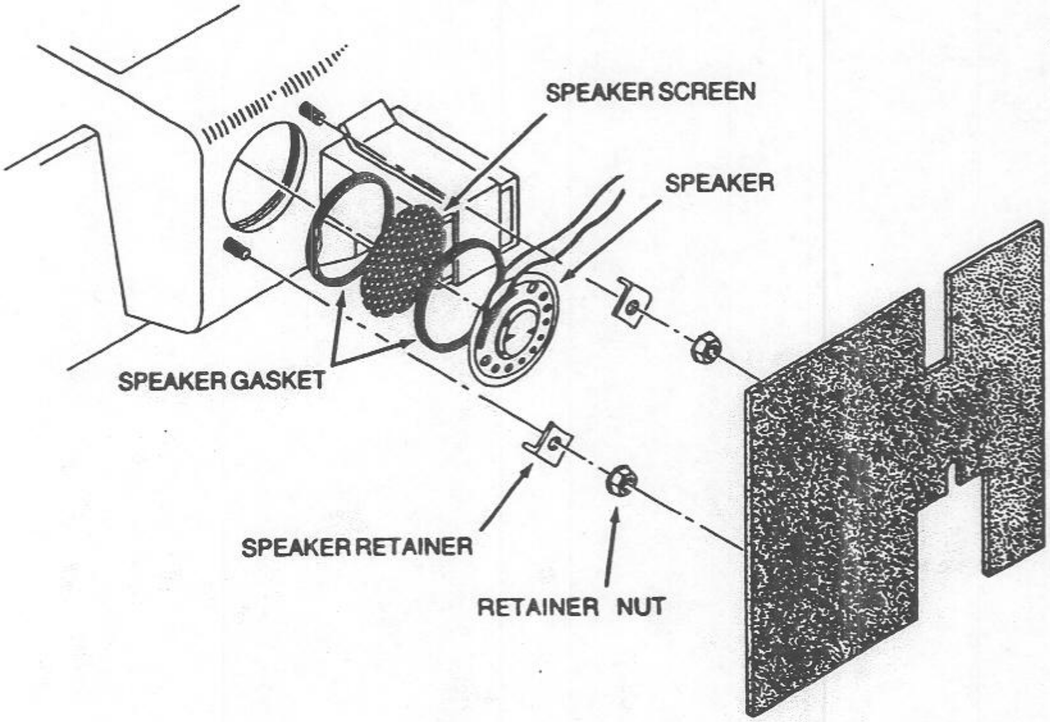

SPEAKER SCREEN
SPEAKER
SPEAKER GASKET
SPEAKER RETAINER
RETAINER NUT

Figure 8-9
ALARM SPEAKER

Controller PCB

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Position the ventilator to access the Controller and Monitor PCBs.
4. Remove and mark the four wiring harnesses for reconnection.
5. Remove the four screws which secure the Controller PCB to the Monitor PCB.
6. The Controller PCB is connected to the Monitor PCB by a 34-pin connector. The Controller PCB may be freed by placing one hand under each corner of the Controller PCB and gently lifting, to separate it from the Monitor PCB.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

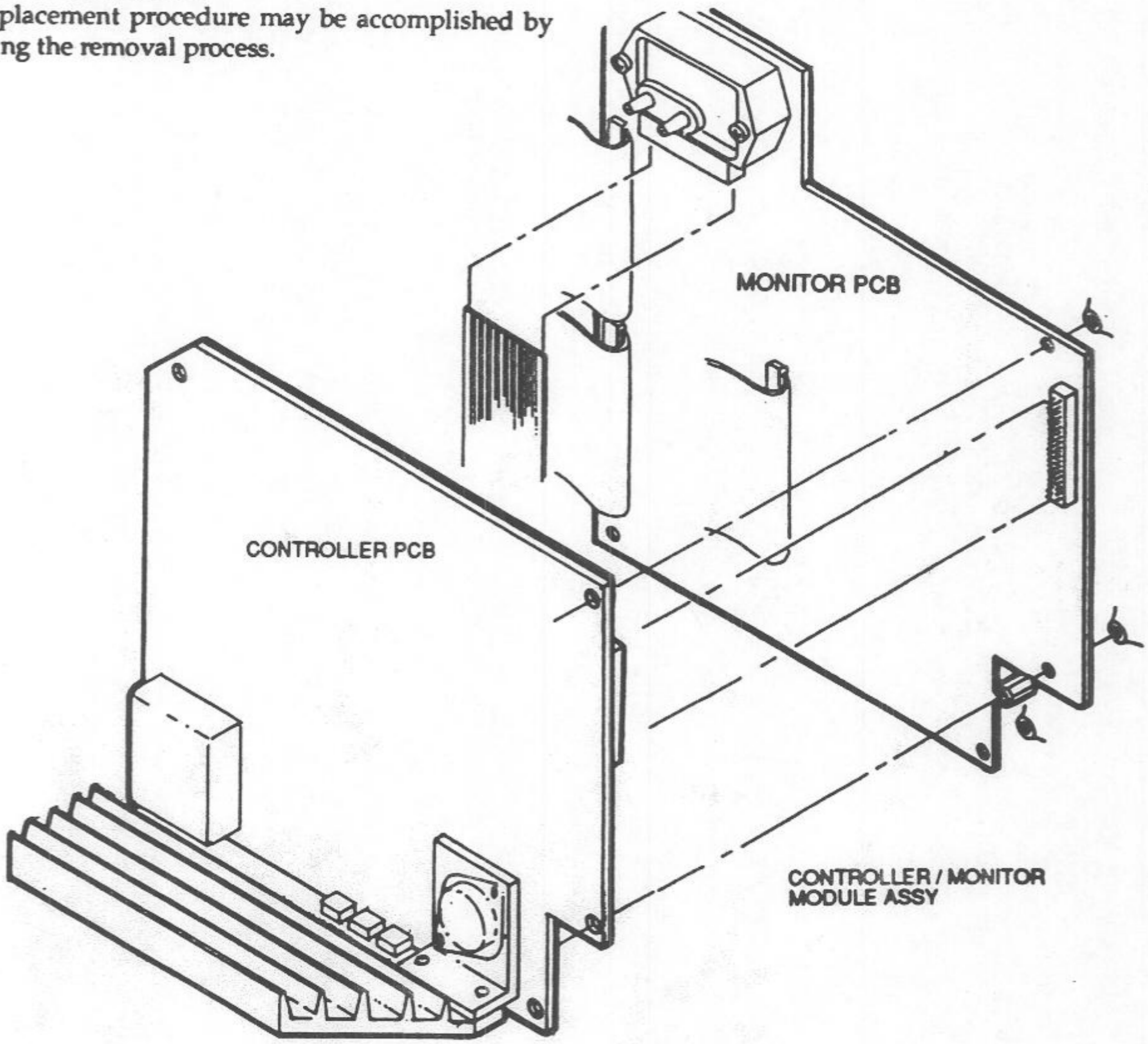


Figure 8-10
CONTROLLER PCB

\\\

Monitor PCB

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Position the ventilator to access the Controller and Monitor PCBs.
4. Remove the Controller PCB (see Controller PCB removal procedure in this section).
5. Remove and mark the three ribbon cables that go to the Display PCB for reconnection.
6. Remove the flexcable at the Monitor PCB by sliding the connector forward to release it.
7. Remove the screw and nylon washer which secure the monitor board to the top case.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

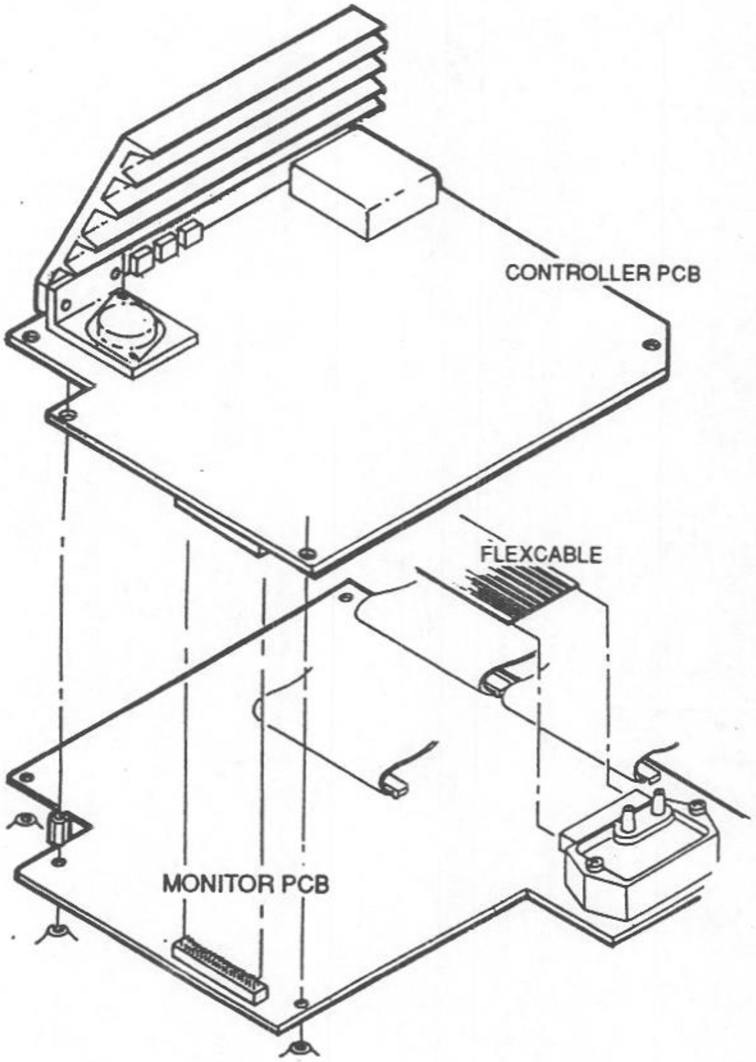


Figure 8-11
MONITOR PCB

Pressure Gauge

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Position the ventilator to access the Controller and Monitor PCBs.
4. Remove the PVC tubing on the rear of the Proximal Airway Pressure Gauge.
5. Remove the two hex nuts the secure the Proximal Airway Pressure Gauge to the Front Panel.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

NOTE

When re-installing the Proximal Airway Pessure Gauge, be sure that the gauge "zero" adjustment screw at the top of the gauge face is aligned with the access hole in the top of the gauge lens.

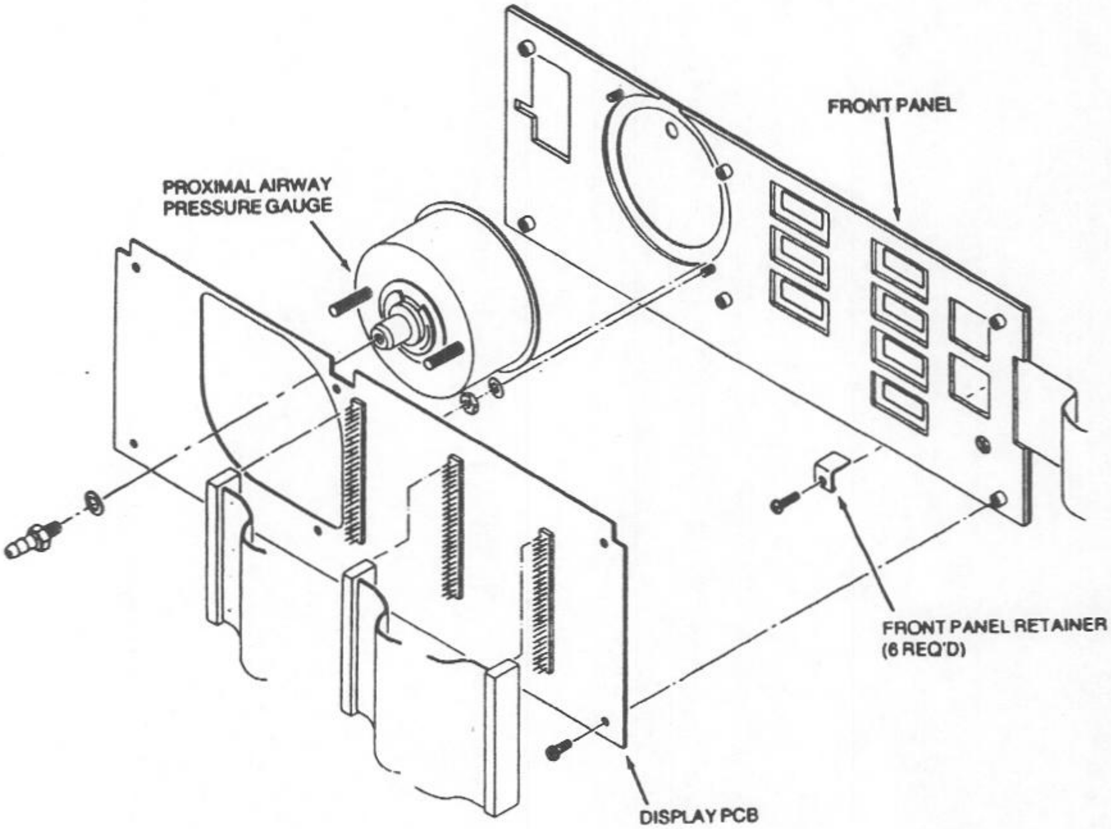

FRONT PANEL
PROXIMAL AIRWAY PRESSURE GAUGE
FRONT PANEL RETAINER (6 REQ'D)
DISPLAY PCB

Figure 8-12
PRESSURE GAUGE

\13

Display PCB

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Position the ventilator to access the Controller and Monitor PCBs.
4. Remove the PVC tubing on the rear of the Proximal Airway Pressure Gauge.
5. Remove the five screws that secure the Display PCB to the Front Panel.
6. Remove the two hex nuts and the washers that secure the Proximal Airway Pressure Gauge.
7. Gently lift the Display PCB up and out to clear the handle well.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

NOTE

The Display PCB must be gently "nested" into the Front Panel. The display modules should recess into the Front Panel and the Display PCB undersurface should contact the mounting screw holes.

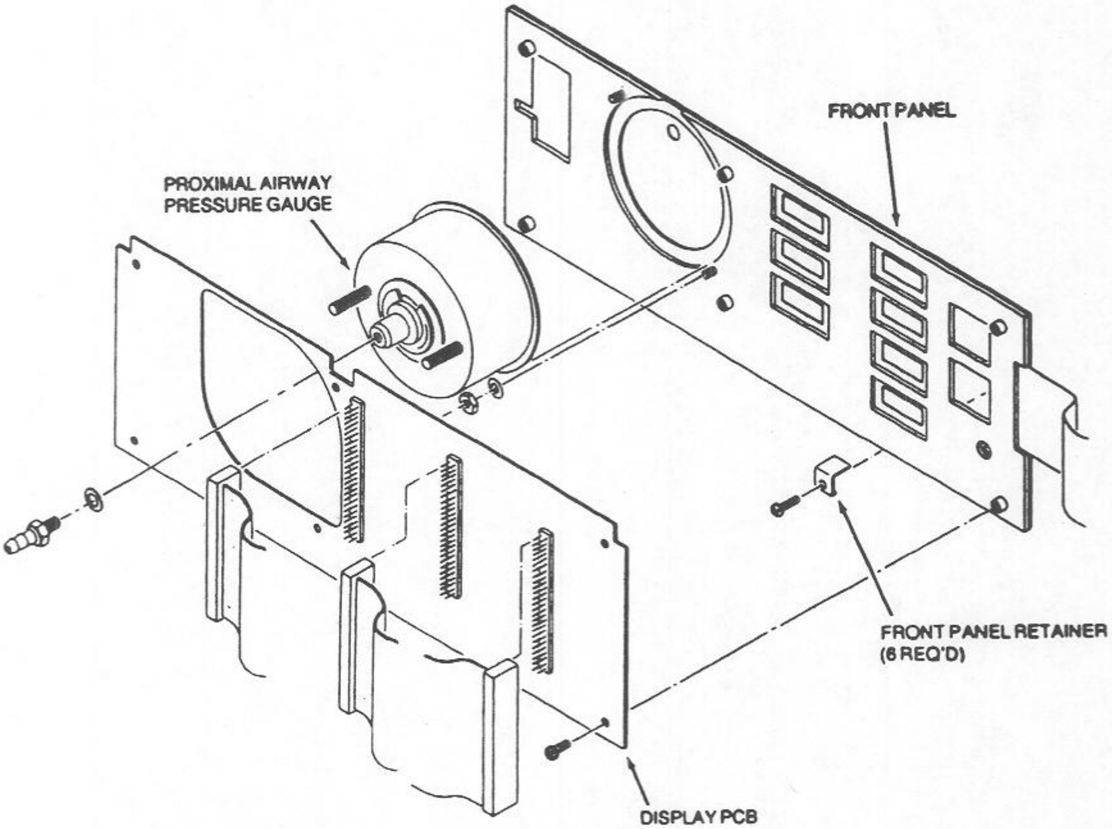

FRONT PANEL
PROXIMAL AIRWAY PRESSURE GAUGE
FRONT PANEL RETAINER (6 REQ'D)
DISPLAY PCB

Figure 8-13
DISPLAY PCB

Front Panel

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Position the ventilator to access the Controller and Monitor PCBs.
4. Remove the PVC tubing on the rear of the Proximal Airway Pressure Gauge.
5. Remove the six screws and brackets that secure the Front Panel to the ventilator case.
6. Apply pressure to the top of the Front Panel and push it inward to clear the ventilator case.
7. Remove the two hex nuts the secure the Proximal Airway Pressure Gauge to the Front Panel.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

NOTE

When reinstalling the Front Panel, remove the old RTV and replace it after the Front Panel has been secured.

When reinstalling the Proximal Airway Pressure Gauge, be sure that the zero adjustment screw at the top of the gauge face is aligned with the access hole in the top of the gauge lens.

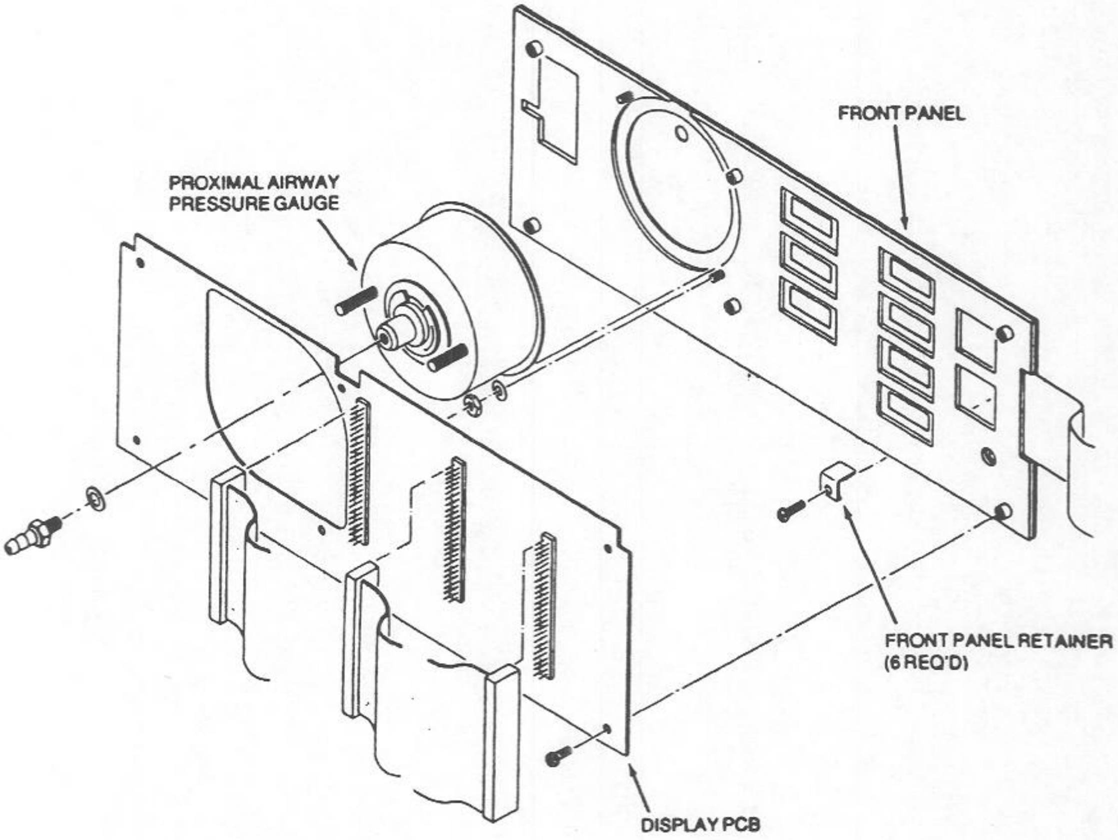

FRONT PANEL
PROXIMAL AIRWAY PRESSURE GAUGE
FRONT PANEL RETAINER (6 REQ'D)
DISPLAY PCB

Figure 8-14
FRONT PANEL

Sensor PCB

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Complete Steps 3 and 4 of the Drive Belt replacement procedure.
4. While supporting the motor, remove the four motor-mount screws and washers.
5. Disconnect the following at the Sensor PCB:
   a. 8-pin connector P1
   b. 3-pin connector P2
   c. 4-pin connector P3
6. Remove the two screws that secure the Sensor PCB bracket to the Lower Cylinder Plate.
7. Remove the Sensor PCB mounting bracket.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal process.

Motor PCB

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Disconnect and mark the connectors going to the Motor PCB for reconnection.
4. Remove the screws holding the Motor PCB in place.
5. Gently remove the Motor PCB.

Replacement Procedure

Replacement may be accomplished by reversing the Removal Procedure.

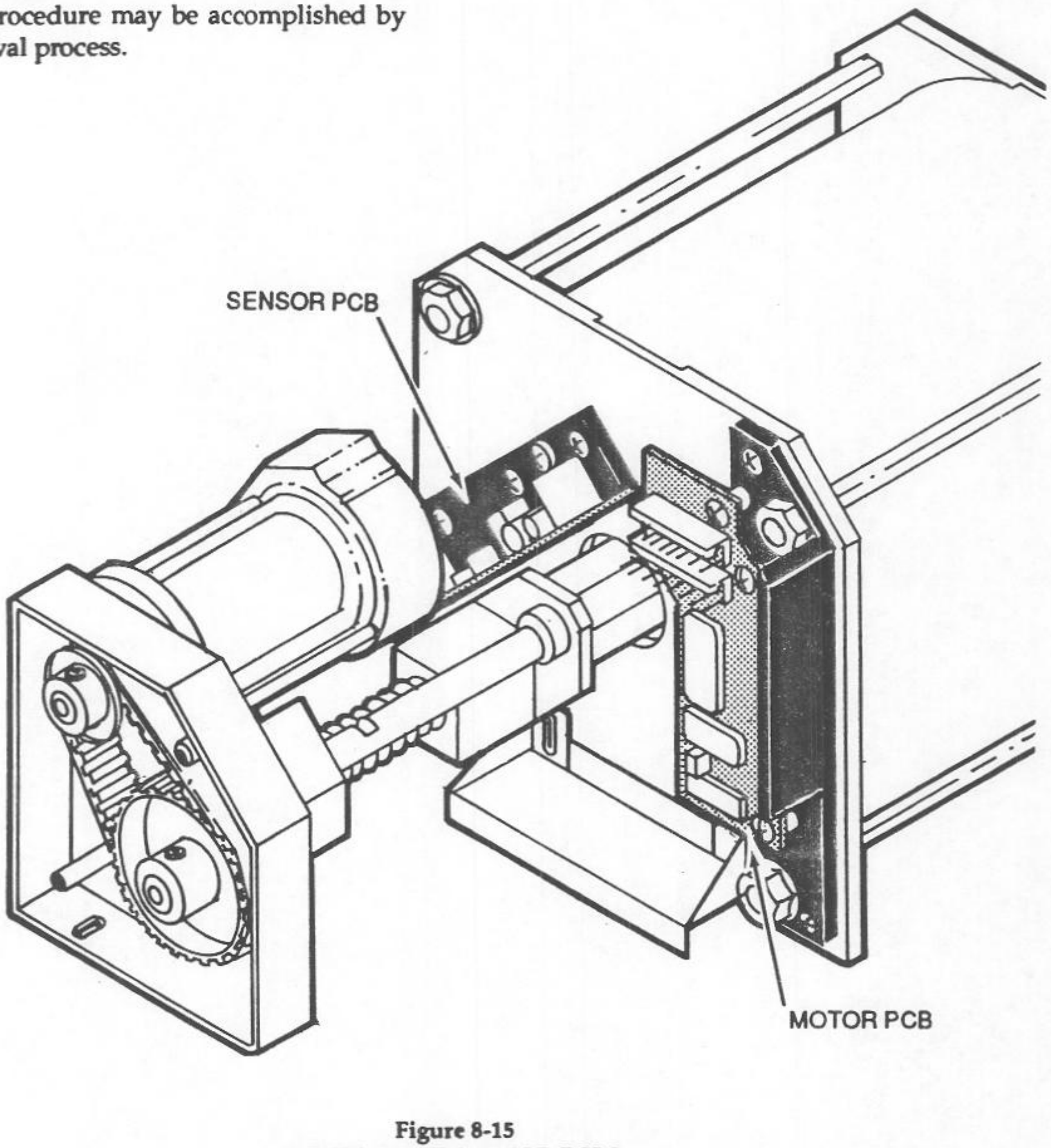


Figure 8-15
SENSOR AND MOTOR PCBS

116

Pump Module Assembly

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove the two kep nuts and the ground wire from the rear of the Exh/Prox fitting plate.
4. Disconnect and mark the connectors going to the Controller PCB, Sensor PCB and Motor PCB for reconnection.
5. Remove the motor-mount screw which secures the ground wire to the pump assembly. Remove wire and loosely replace screw.
6. Position ventilator to access the five screws on the bottom of the ventilator. Remove the five screws and washers.
7. Reposition the ventilator to operating position, to access the two screws above the air inlet filter door.
8. Remove the air inlet filter door and filter.
9. Remove the two screws above the filter door.
10. Remove the wye fitting from the black elbow fitting at the dump port.
11. Gently lift the pump assembly.

Replacement Procedure

Replacement may be accomplished by reversing the Removal Procedure.

Battery Level Indicator

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Unsolder the wires from the meter(s).
4. Using an offset screwdriver, remove the two bracket mounting screws and the Battery Level Indicator Mounting Bracket.

Replacement Procedure

Replacement is accomplished by reversing the removal procedure.

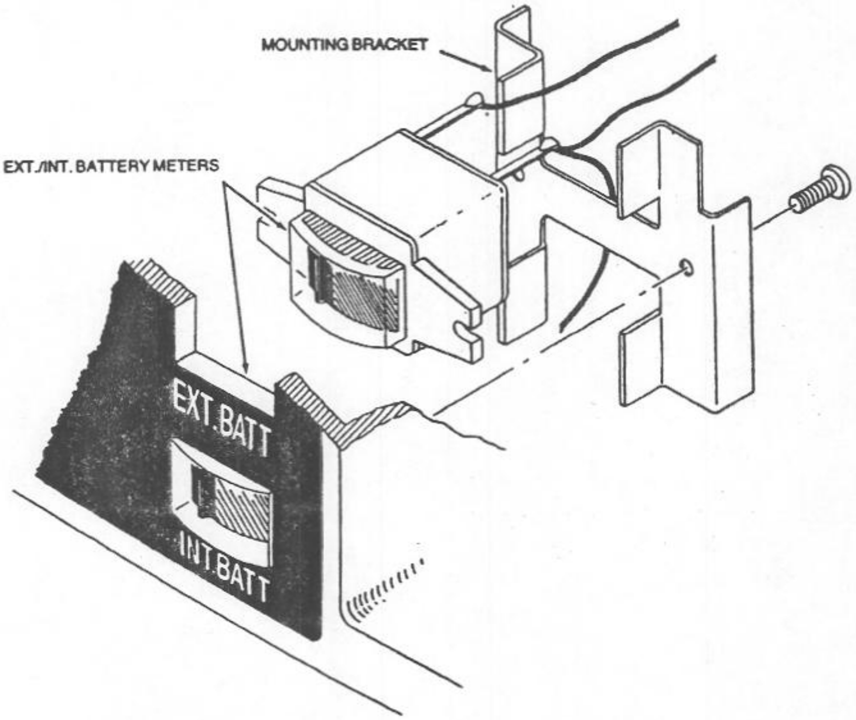


Figure 8-17
BATTERY LEVEL INDICATOR

117

Exh/Prox Fittings

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove all tubing from the Exh/Prox and Patient fittings.
4. Remove the two nuts from the threaded studs. The retainer place with the Exh/Prox fittings attached may now be removed as one unit.
5. To remove the Exh/Prox fittings, use a wrench to loosen the single hex nut that secures each fitting to the retainer plate. Use finger pressure to remove the hex nuts and disengage.
6. To remove the 3/4" Patient fitting, place masking tape over the serrated jaws of slip-joint pliers and turn the hex collar on the Patient fitting counter-clockwise until the o-ring seal is no longer compressed. The 3/4" patient fitting may then be removed with finger pressure.

Replacement Procedure

Replacement is accomplished by reversing the removal procedure.

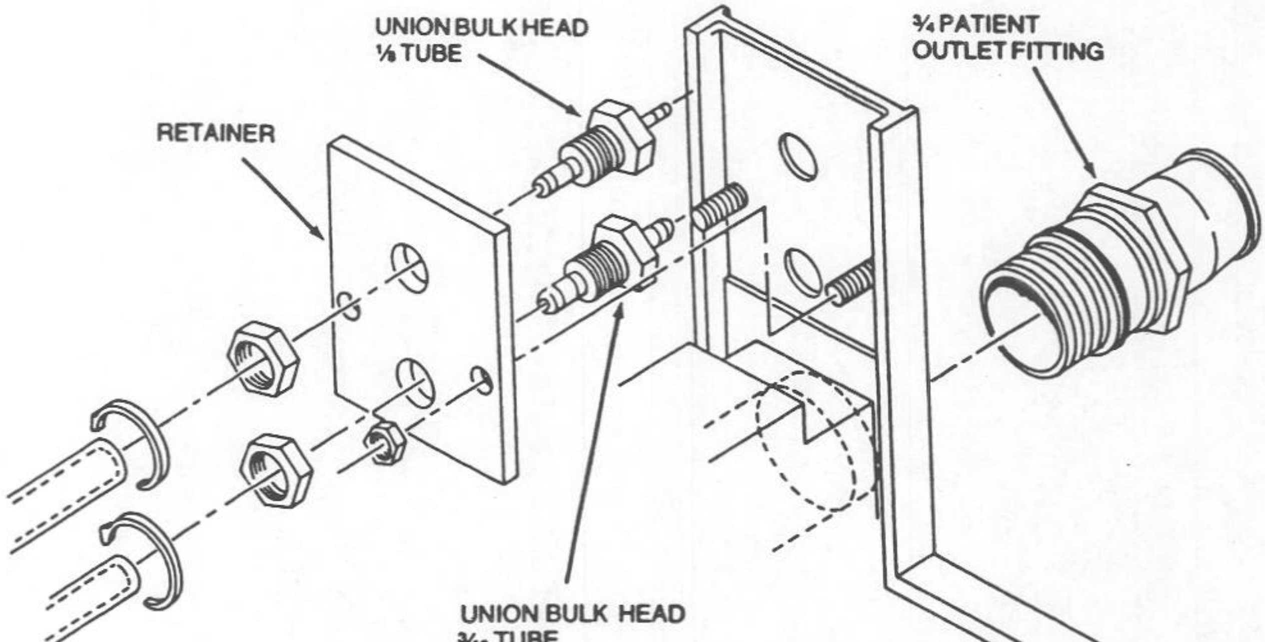


Figure 8-18
EXH/PROX FITTINGS

Terminal Block

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Complete Steps 3 and 4 of the Drive Belt replacement procedure.
4. While supporting the motor, remove the four motor-mount screws and washers.
5. Set the motor atop the pump module cylinder or to one side to access the terminal block.
6. Loosen the recessed screws that secure the AC power cord and the AC filter leads to the terminal block. Note the lead designations marked on the terminal block dielectric shield.
7. Remove the two screws that secure the terminal block and lift it out.
8. If the dielectric shield is removed or replaced, be sure it is repositioned under the terminal block correctly.

Replacement Procedure

Replacement is accomplished by reversing the removal procedure.

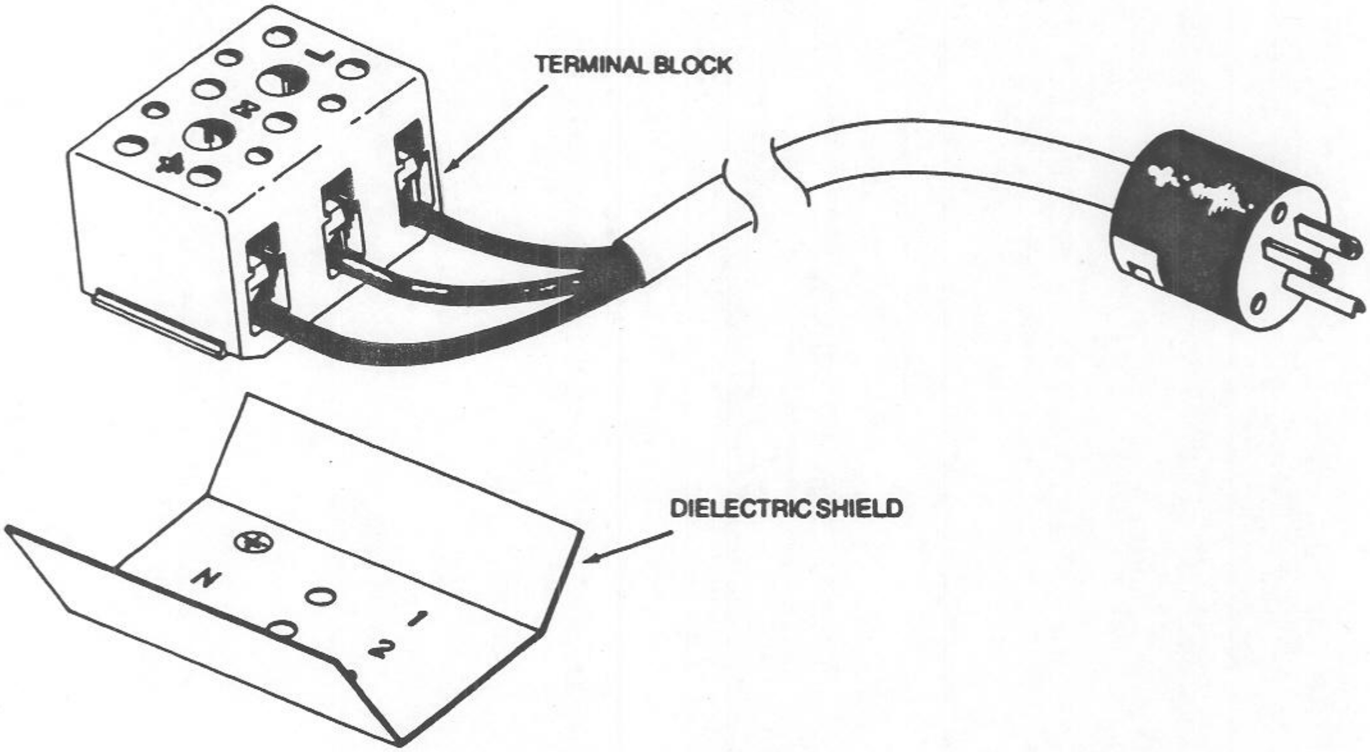


Figure 8-19
TERMINAL BLOCK

Unlock Switch

Removal Procedure

1. Disconnect the AC power cord from the AC power source.
2. Remove unit cover (see Section 4).
3. Remove the circuit breaker mounting nut (see Circuit Breaker removal procedure).
4. Remove the circuit breaker from the Front Panel and position it to access the Unlock Switch.
5. Unsolder the two wires on the Unlock Switch terminals.
6. Using an offset phillips screwdriver, remove the two bracket screws.
7. Remove the bracket and pull the Unlock Switch from the recessed mount.

Replacement Procedure

The replacement procedure may be accomplished by reversing the removal procedure.

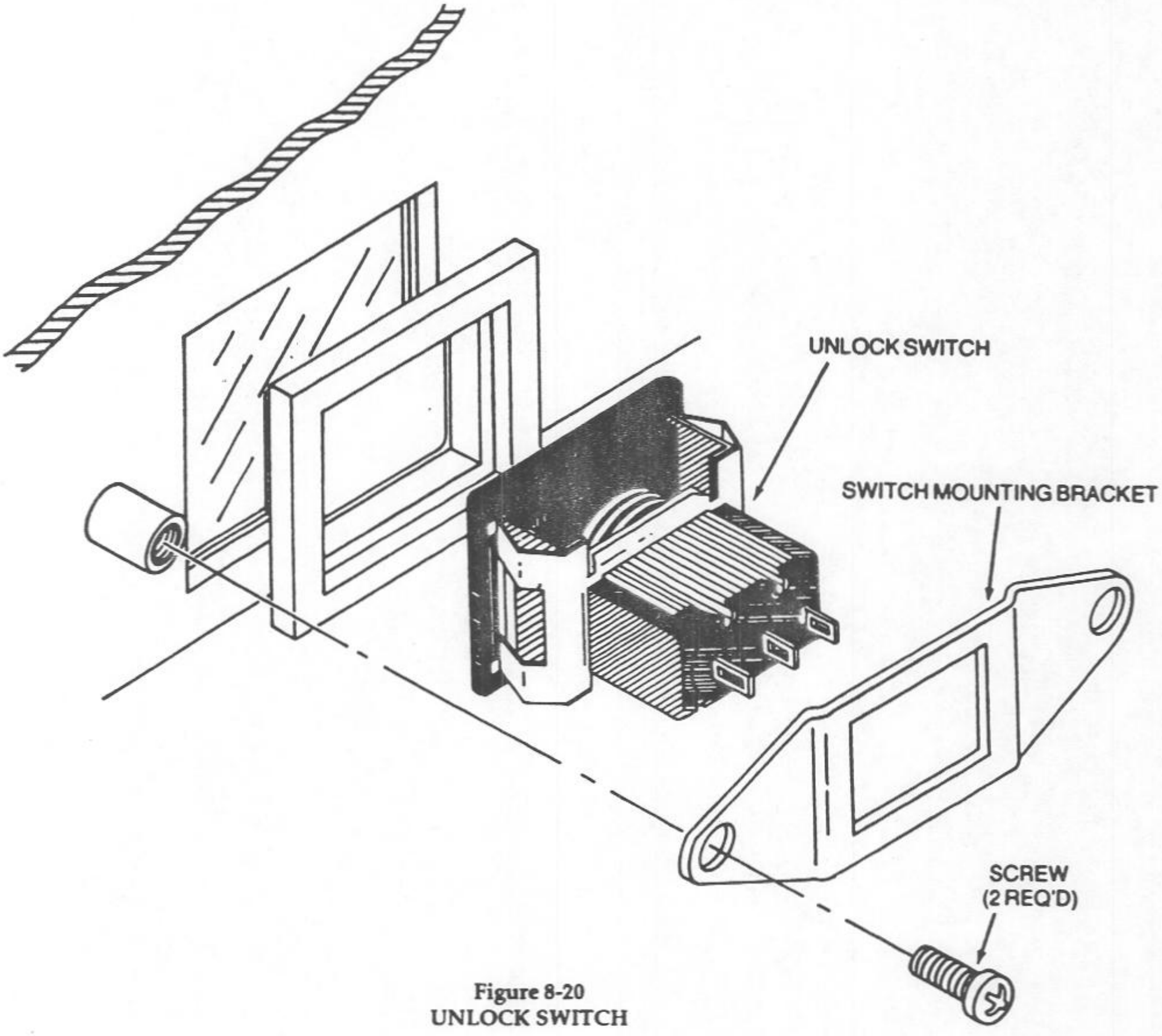


Figure 8-20
UNLOCK SWITCH

\120

SECTION 9

BEAR® 33 VOLUME VENTILATOR PREVENTIVE MAINTENANCE PROCEDURE

Recommended Service Procedure

Preventive maintenance on the ventilator should be completed every 7,000 hours of operation, or earlier if required, or a minimum of once each year. Maintenance is intended to be done in the hospital.

Ventilator Preventive Maintenance includes:

- Visually inspecting and cleaning of external surfaces, controls, attachments and accessories.
- Removing top case and cleaning the interior of the unit.
- Visually inspecting all tubing, electrical wiring connectors, and crimps, screws, nuts and hardware. Checking the general condition of all other internal components or assemblies.
- Pneumatic and electronic testing and calibrating of the ventilator.
- Performing the Operational Verification Procedure
- Replacing the Drive Belt, P/N 52000-01991
- Replacing, if required, the Internal Battery, P/N 56000-50010
- Replacing the filter
- Cleaning and lubricating Ball Screw Assembly and Piston Guide Shaft Assembly

Bear Medical Systems Replacement Parts

50000-13033	Preventive Maintenance Kit; includes:
52000-01991	Drive Belt
51000-08122	Filter (two)
56000-50010	Internal Battery (as required)

Bear Medical Systems Equipment Required

50000-10133	Clinical Instruction Manual
50000-12075	Operational Verification Procedure
50000-12066	Maintenance Manual
50000-08020	Standard Patient Circuit

Supplies Required

	Isopropyl Alcohol
	Absorbent Wipes
52000-00998	Magnalube, Lubricant

Exterior Inspection

1. Clean the exterior of the unit with an isopropyl alcohol solution. Wipe all surfaces with a soft cloth or disposable wipe moistened in the cleaning solution.
2. Inspect the exterior surfaces of the ventilator for broken or loose knobs. Check the display panel for scratches, cracks and alignment of LED indicators. Check all front and rear panel fittings, and accessories for security. Check the AC electrical cord and plug for damage. Record the reading of the hour meter on the maintenance checklist.

EQUIPMENT REQUIRED

EQUIPMENT	RECOMMENDED SUPPLIER
Pneumatics	
Pressure Regulator, 0-2 psi	Fairchild-Kendall Model 10, #10163 or equivalent
Pressure Gauge, 0-150 cmH_2O ±1% F/S	Marshalltown, Model 86F, with scale in cmH_2O, Wallace & Tierman Model FA 14170 or equivalent
Spirometer	Collins Model P800 or equivalent
Stopwatch	General purpose
Vacuum	General purpose
Electronics	
Digital Multimeter	Tektronix DM 502A or equivalent
Oscilloscope	Tektronix SC502 or equivalent
Digital Frequency Counter	Tektronix DC504 or equivalent
Power Supply, for above	Tektronix TM504
Current Leakage Tester	Biotek Model 150M or equivalent
Ground Impedance Tester	Biotek Model 11 Adapter or equivalent

Ground Resistance Test

Always follow manufacturer's instructions for test equipment operation.

1. Connect a properly functioning leakage and gounding tester between the ground connection on the hospital grade AC plug (middle lug) and the chassis of the ventilator (any unpainted exposed metal part). See Figure 9-1.
2. With the tester connected and operating, there should be no more than 0.10 ohms resistance between the plug ground connector, and the ventilator chassis ground.

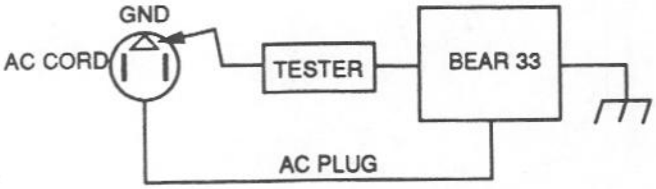


Figure 9-1
GROUND RESISTANCE TESTER CONNECTION

Current Leakage Test

Always follow manufacturer's instructions for test equipment operation.

1. Connect the ventilator to a properly functioning current leakage tester. See Figure 9-2.
2. Turn leakage tester on.
3. Current leakage should be less than 30 µA, grounded and ungrounded.

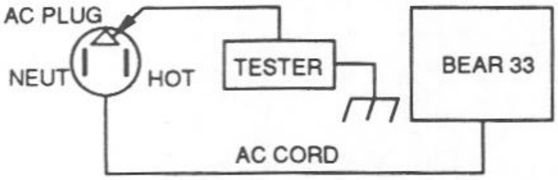


Figure 9-2
CURRENT LEAKAGE TESTER CONNECTION

Interior Inspection

1. Turn the ventilator OFF and disconnect from AC power.
2. Remove the cover as described in Section 4.
3. Vacuum the inside of the unit. Inspect for damaged wires or connectors or lodged particles.
4. Inspect all harnesses and connectors. Be sure all connectors are tight.
5. Inspect tubing and fittings.

Install the Preventive Maintenance Kit

See Section 8 for detailed instructions for PM Kit installation.

Clean and Lubricate the Pump Assembly

Using the magnalube and a clean cotton swab, lubricate the ball screw assembly and the guide rods.

Internal Battery Check

1. Test the ventilator after it has been plugged into wall AC for 24 hours.
2. Unplug unit.
3. Connect a voltage tester to the internal battery according to the manufacturer's instructions.
4. Measure the voltage during a ventilator stroke; if less than 11 volts, replace the battery.

Pneumatic Verification and Calibration

Refer to Section 5 of the Service Manual for pneumatic verification and calibration instructions.

Electronic Verification and Calibration

Refer to Section 5 of the Service Manual for verification and calibration instructions for the following:

- Control PCB
- Monitor PCB
- Display PCB
- Sensor PCB
- Motor PCB

PROCEDURE COMPLETE

BEAR® 33 VOLUME VENTILATOR
PREVENTIVE MAINTENANCE CHECK LIST

This checklist is for use during the BEAR® 33 Preventive Maintenance Procedure.

BEAR® 33 Serial Number____________ Hour meter reading____________ Today's date ____________

Service Location ________________ Service organization ________________

Address ________________ Address ________________

City, State, Zip ________________ City, State, Zip ________________

Contact ________________ Service Person ________________

Phone (___) ________________ Phone (___) ________________

MAINTENANCE STEPS

OPERATION		TEST RESULTS	ACCEPT	UNACCEPT
Exterior Inspection				
Clean		As specified	☐	☐
Inspect		As specified	☐	☐
Electrical Tests				
Ground Resistance		As specified	☐	☐
Current Leakage		As specified	☐	☐
Interior Inspection				
Vacuum		As specified	☐	☐
Inspect		As specified	☐	☐
Install PM Kit	Refer to Section 8	As specified	☐	☐
Clean and Lubricate	Refer to Section 8	As specified	☐	☐
Check Internal Battery		As specified	☐	☐
ELECTRONIC VERIFICATION AND CALIBRATION (Refer to Section 5)				
Control PCB		As specified	☐	☐
Monitor PCB		As specified	☐	☐
Display PCB		As specified	☐	☐
Sensor PCB		As specified	☐	☐
Motor PCB		As specified	☐	☐
PNEUMATIC VERIFICATION AND CALIBRATION (Refer to Section 5)				
Operational Verification	Refer to Section 3	As specified	☐	☐

DO NOT RELEASE THE VENTILATOR FOR USE IF IT DOES NOT PASS ALL OF THE VERIFICATION PROCEDURES SPECIFIED IN THE CHECKLIST. TO DO SO COULD RESULT IN PERSONAL INJURY OR PROPERTY DAMAGE. REFER THE VENTILATOR TO A BEAR MEDICAL SYSTEMS SERVICE TECHNICIAN, A BEAR MEDICAL SYSTEMS AUTHORIZED SERVICING DEALER, OR A BEAR MEDICAL SYSTEMS TRAINED HOSPITAL SERVICE TECHNICIAN FOR APPROPRIATE REPAIR AND/OR CALIBRATION.

Signature________________________

PROCEDURE COMPLETE

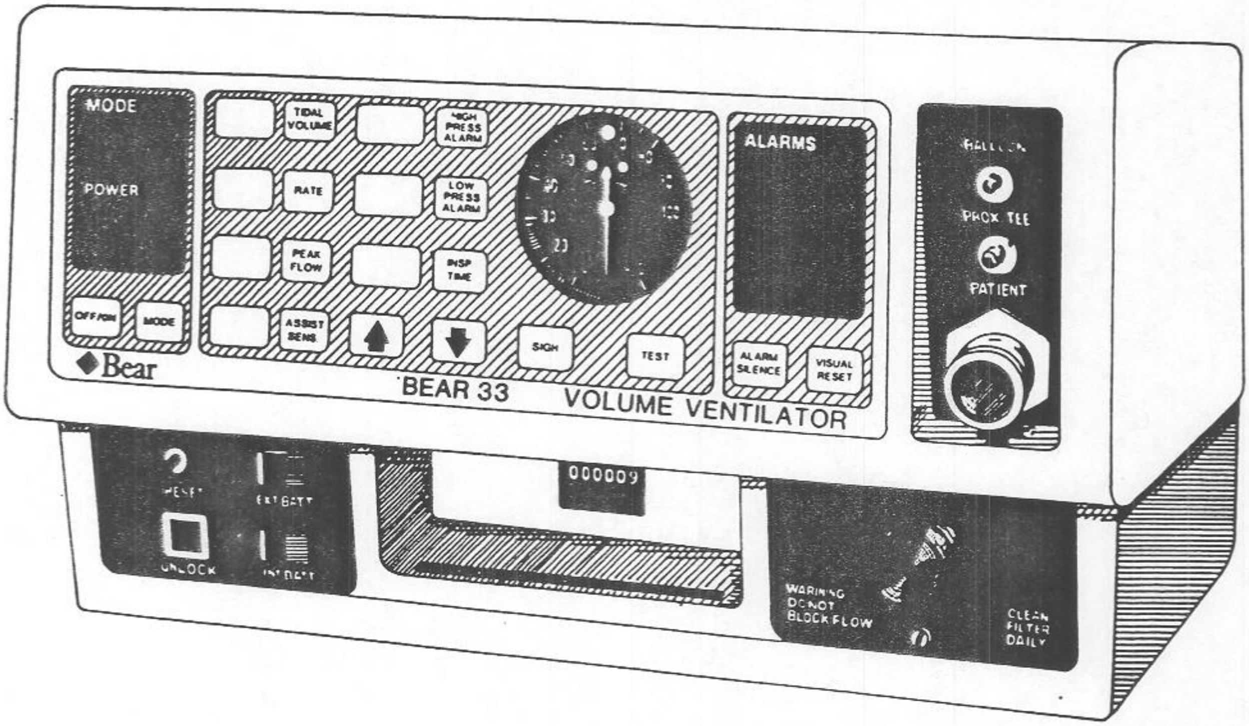
SECTION 10

BEAR® 33 VOLUME VENTILATOR PARTS LIST

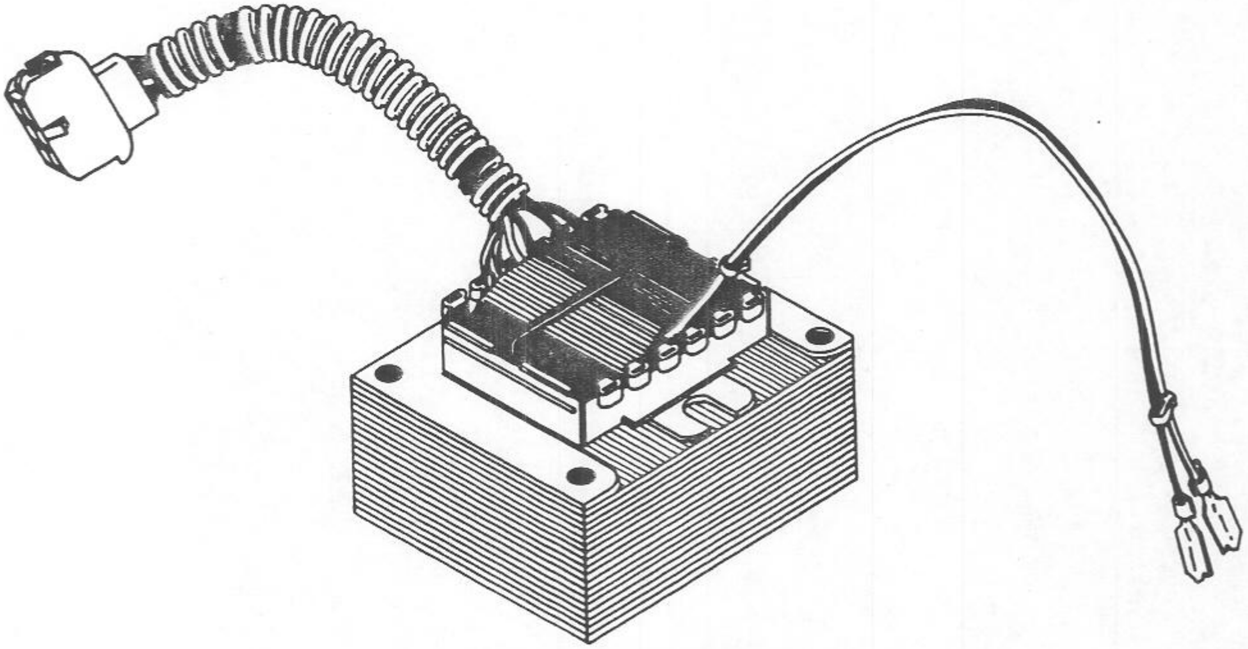
This parts list is divided into two sections. The first section is an aphabetical listing of parts. The second section is series of illustrations showing major parts and assemblies.

Section 1 • Alphabetical Listing

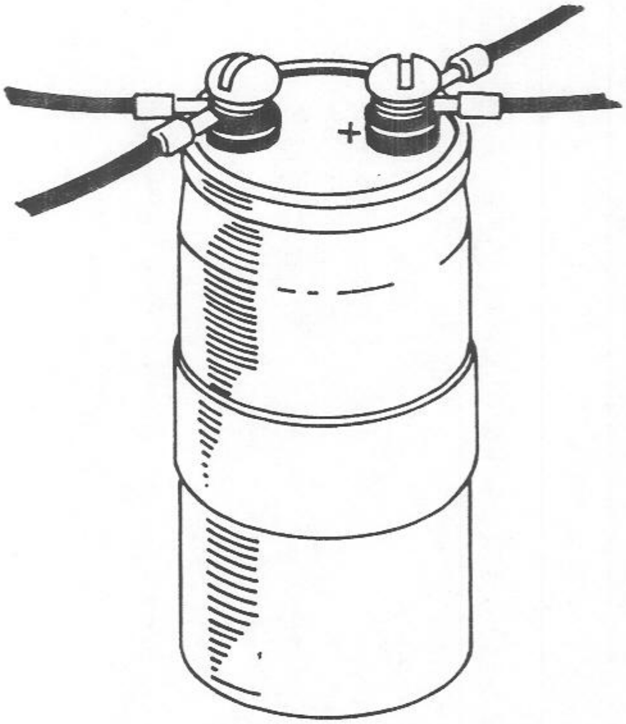
Alarm Cable, Remote (40 ft)	56090-10088
Alarm Jack, Rear	56090-20366
Alarm, Remote (Sonalert)	13044-00101
Alarm, Remote, Packaged	51000-08131
Bacterial Filter, Mainflow	51000-01054
Battery, Internal	56000-50010
Belt, Drive	52000-01991
Block, Terminal	56090-20274
Boot, Switch Actuator	51000-08074
Bracket, Humidifier, Packaged	51000-08124
Bumper	52000-00853
Bumper, Screw	53014-54016
Bumper, Spacer (used on early models only)	51000-08213
Cable Assembly, External Battery	51000-08126
Cable Assembly, External Battery, Packaged	51000-08127
Cable Assembly, External Battery, Auto Lighter Adaptor	51000-08128
Cable Assembly, External Battery, Auto Lighter Adaptor, Packaged	51000-08129
Capacitor, 8000 MFD, 30 VDC	56021-10141
Carton, Shipping	51000-08157
Circuit Breaker (used on early models only)	56000-20018
Clip, Tubing	51000-08105
Clip, Tubing (package of 10)	51000-08106
Controller PCB Assembly	51000-08226
Cover, Battery	51000-08102
Cover, Inlet Port	51000-08110
Cushion, Battery	51000-08103
Display PCB Assembly	51000-08065
Door, Air Inlet/Filter Retain	51000-08095
Door, Filter Retainer	51000-08135
Electronics Module Assembly	51000-08123
Filter, Air Inlet	51000-08121
Filter,Air Inlet (4 pack)	51000-08122
Flextube, Molded 4"	51000-08081
Flextube, Tracheostomy	51000-08114
Gasket, Speaker	51000-00835
Gauge, Pressure	52000-01073
Kit, Patient Circuit	51000-08020
Kit, Mainflow Bacterial Filter	51000-08104
Manual, Maintenance	51000-12066
Meter, External Battery	56000-40002
Meter, Internal Battery	56000-40002
Monitor PCB Assembly	51000-08067
Motor/Encoder Assembly	56000-80012
Motor PCB Assembly	51000-08220
Plug, Auto Lighter	56090-20352
Plug, AC, Hospital Grade	56090-20014
Power Cord Assembly (AC)	51000-08031
Pulley, Drive	52000-01992
Pulley, Motor	52000-01990
Pump Module Assembly	51000-08032
Rectifier, Bridge	56030-20004
Retainer, Power Cord	51000-08087
Retainer, Speaker	51000-08034
Screen, Speaker	51000-08033
Sensor PCB Assembly	51000-08196
Speaker, Alarm	56000-70006
Switch, Unlock	56080-10062
Tee, Proximal Pressure	51000-08085
Tee, Proximal Pressure, Packaged	51000-08116
Transformer Assembly	51000-08145
Tube, Oxygen Accumulator	51000-08107


MODE
POWER
OFF/ON
MODE
TIDAL VOLUME
RATE
PEAK FLOW
ASSIST SENS
HIGH PRESS ALARM
LOW PRESS ALARM
INSP TIME
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
BALLOON
PROX TEE
PATIENT
Bear
BEAR 33 VOLUME VENTILATOR
RESET
EXT BATT
UNLOCK
INT BATT
000009
WARNING DO NOT BLOCK FLOW
CLEAN FILTER DAILY

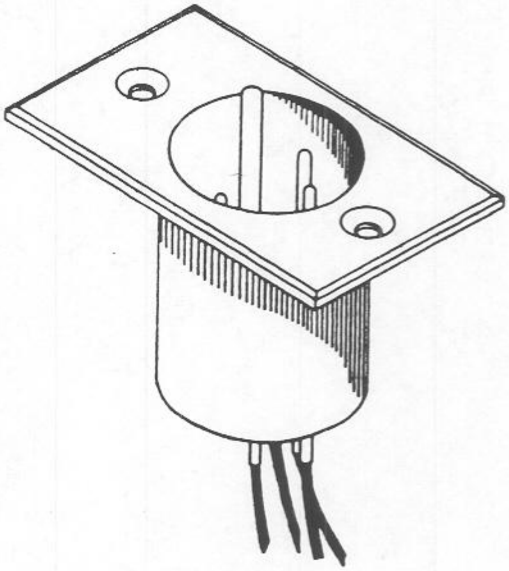
Bear
InterMed



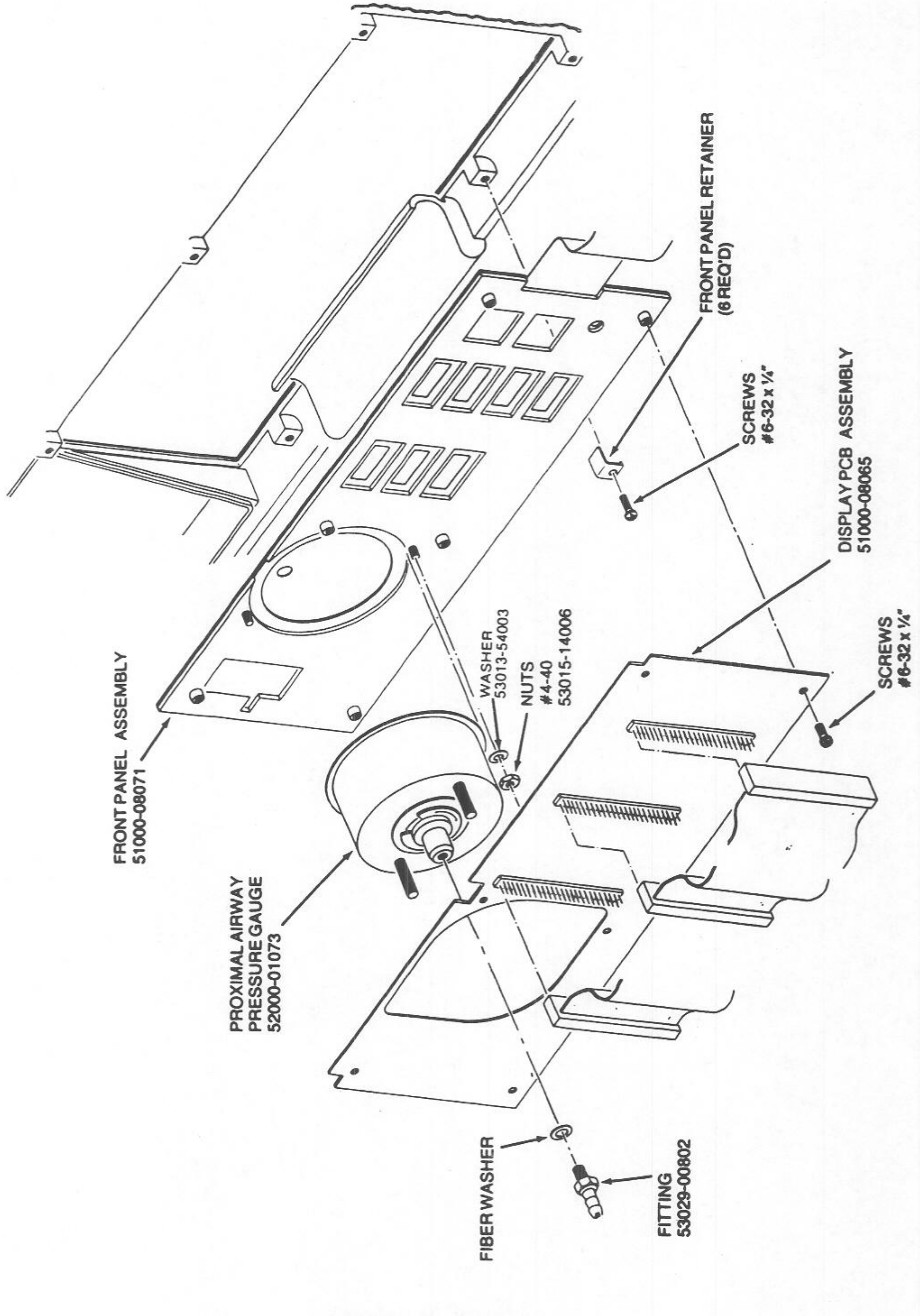
POWER TRANSFORMER ASSEMBLY
51000-08145

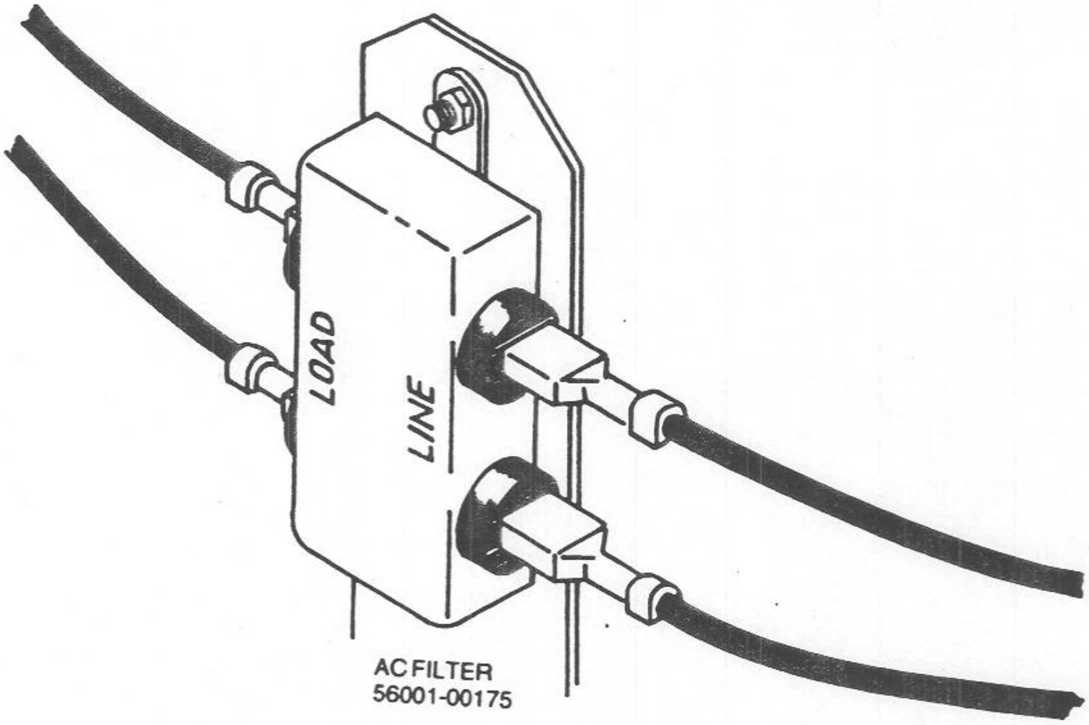


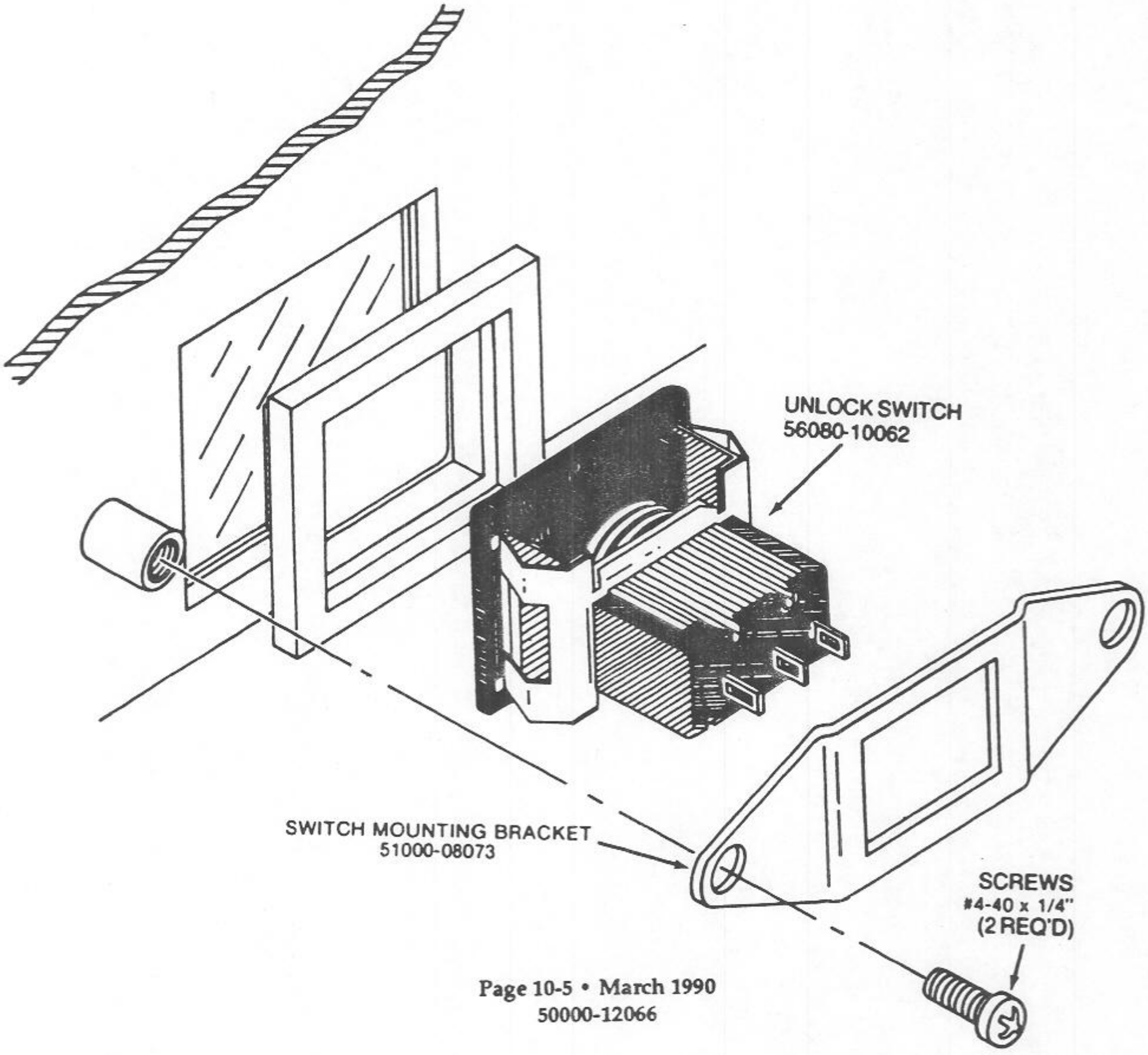
CAPACITOR,
8000 MFD., 30 VDC
56021-10141

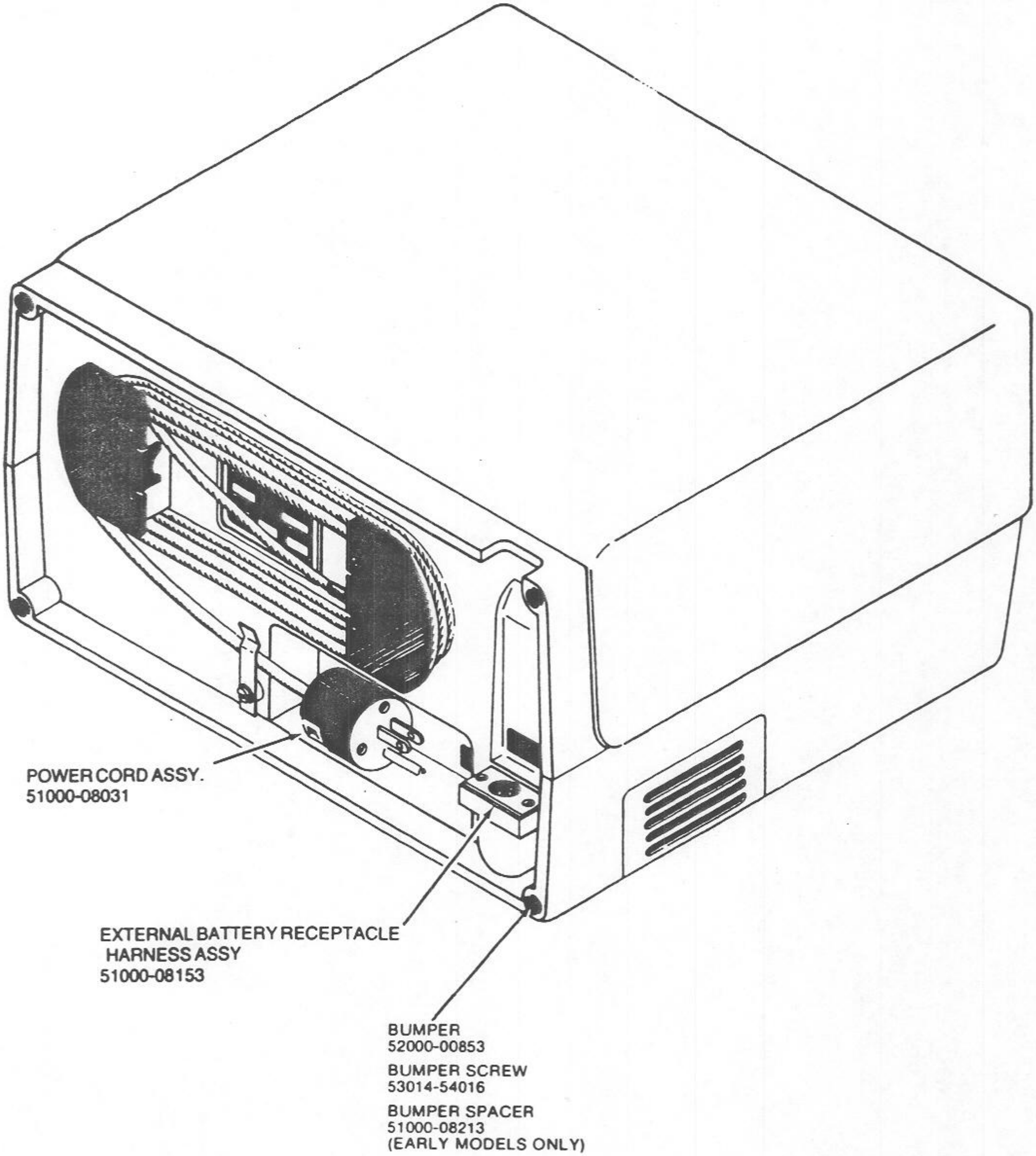


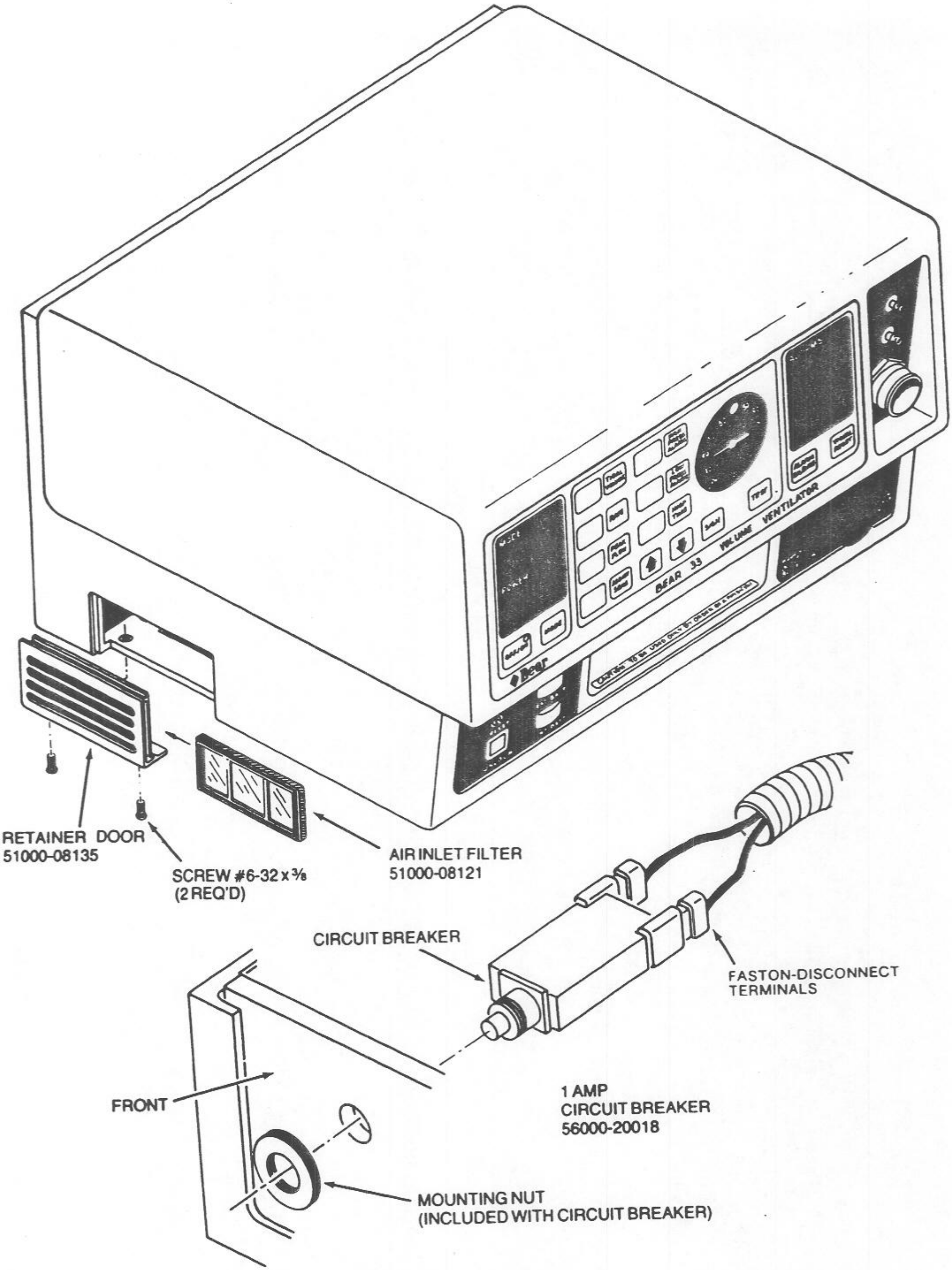
EXTERNAL BATTERY
RECEPTACLE HARNESS ASSY.
51000-08153

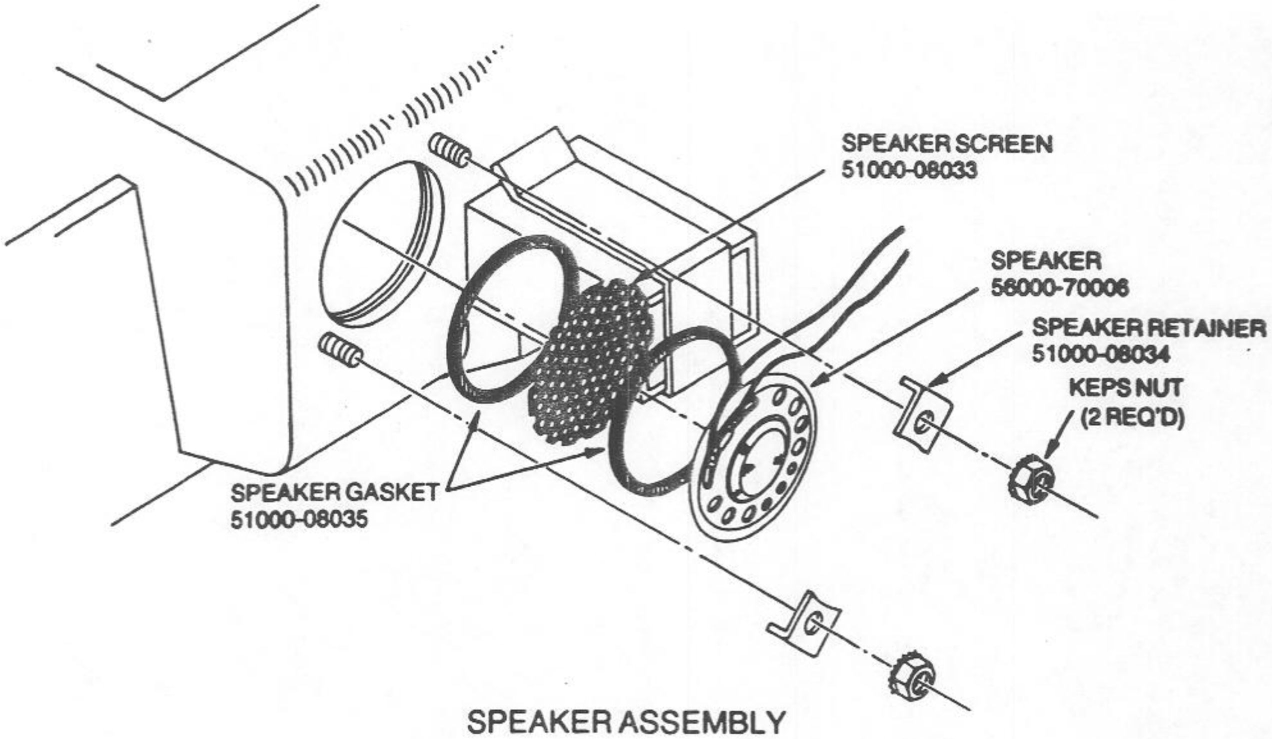

FRONT PANEL RETAINER
(6 REQ'D)
SCREWS
#6-32 x ¼"
DISPLAY PCB ASSEMBLY
51000-08065
SCREWS
#6-32 x ¼"
FRONT PANEL ASSEMBLY
51000-08071
WASHER
53013-54003
NUTS
#4-40
53015-14006
PROXIMAL AIRWAY
PRESSURE GAUGE
52000-01073
FIBER WASHER
FITTING
53029-00802


LOAD
LINE
AC FILTER
56001-00175

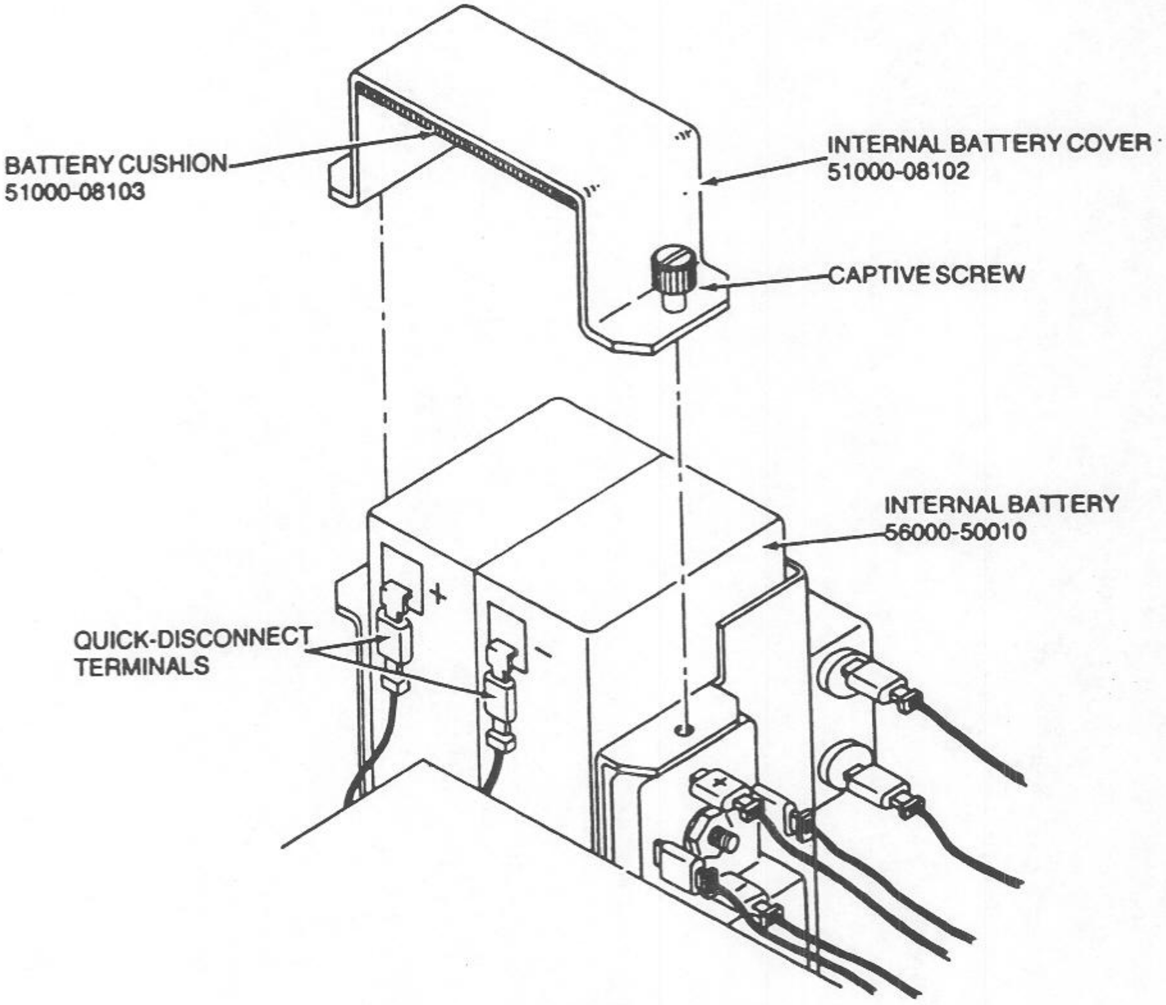

UNLOCK SWITCH
56080-10062
SWITCH MOUNTING BRACKET
51000-08073
SCREWS
#4-40 x 1/4"
(2 REQ'D)


POWER CORD ASSY.
51000-08031
EXTERNAL BATTERY RECEPTACLE
HARNESS ASSY
51000-08153
BUMPER
52000-00853
BUMPER SCREW
53014-54016
BUMPER SPACER
51000-08213
(EARLY MODELS ONLY)

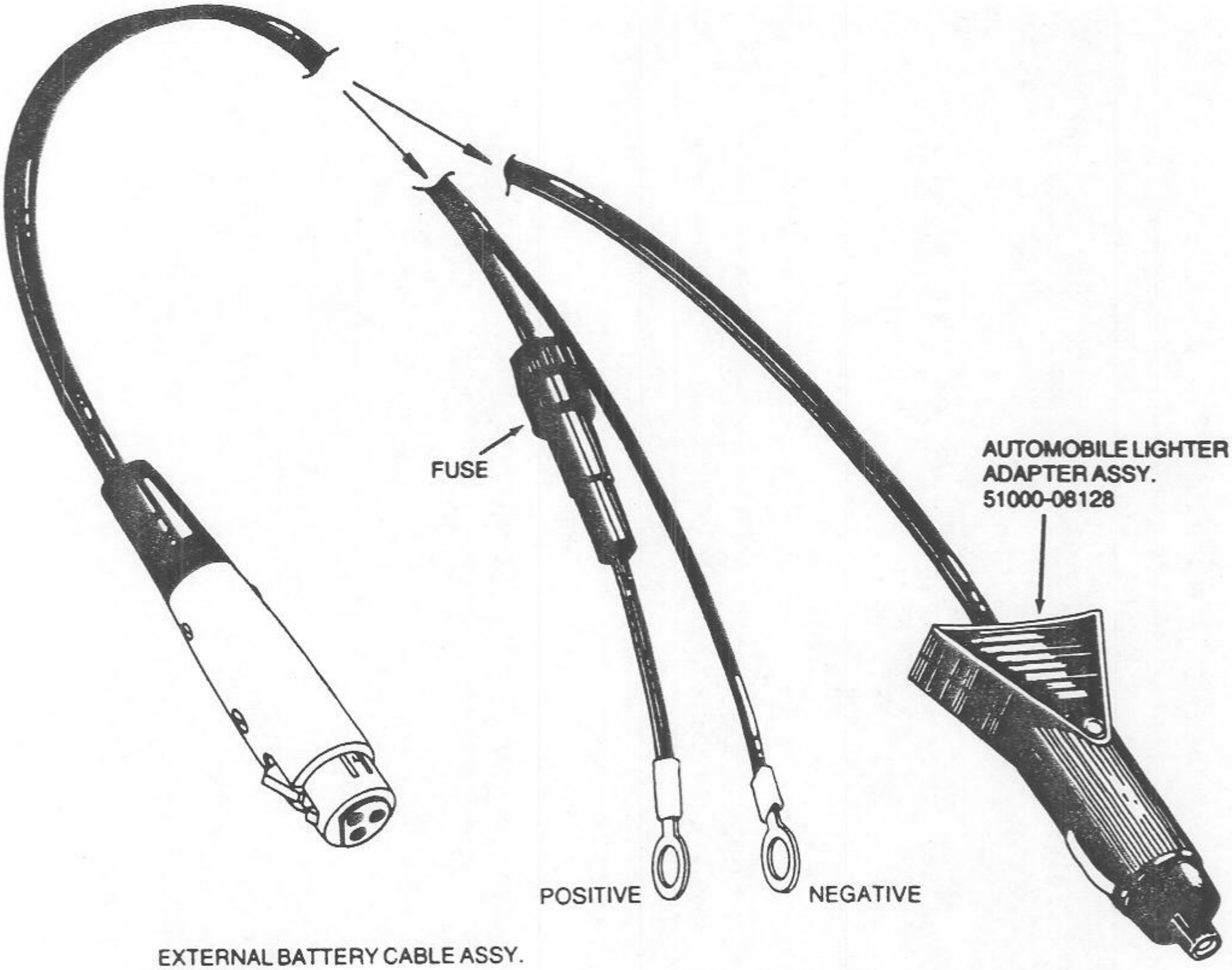

BEAR 33 VOLUME VENTILATOR
RETAINER DOOR
51000-08135
SCREW #6-32 x ⅜
(2 REQ'D)
AIR INLET FILTER
51000-08121
CIRCUIT BREAKER
FASTON-DISCONNECT
TERMINALS
FRONT
1 AMP
CIRCUIT BREAKER
56000-20018
MOUNTING NUT
(INCLUDED WITH CIRCUIT BREAKER)


SPEAKER SCREEN
51000-08033
SPEAKER
56000-70006
SPEAKER RETAINER
51000-08034
KEPS NUT
(2 REQ'D)
SPEAKER GASKET
51000-08035

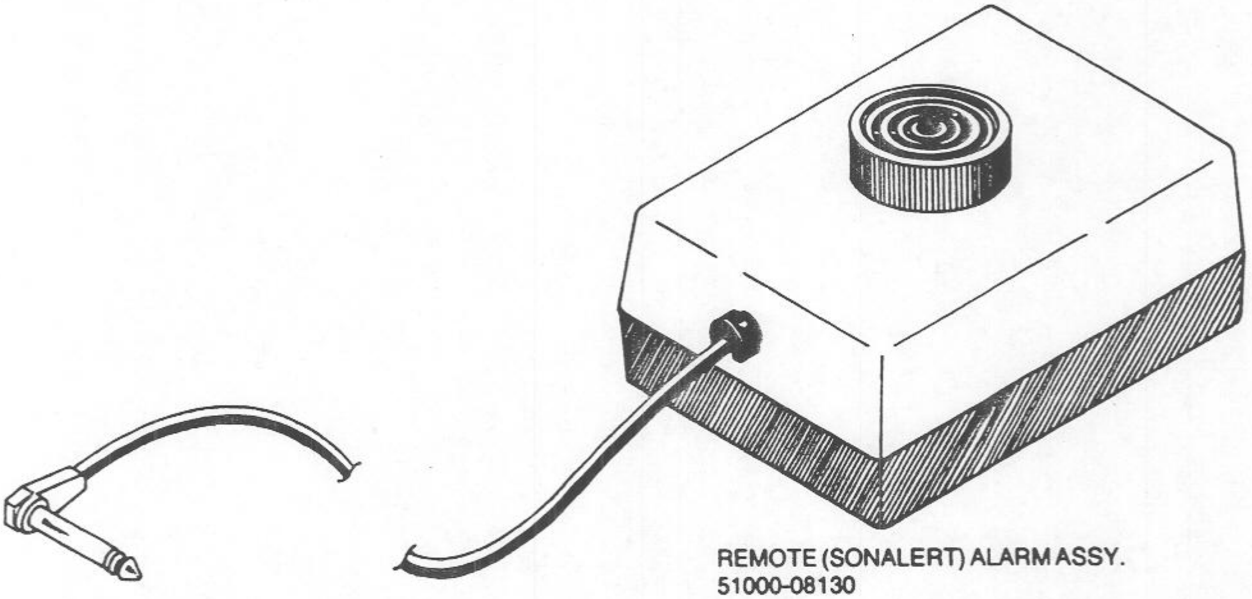
SPEAKER ASSEMBLY


BATTERY CUSHION
51000-08103
INTERNAL BATTERY COVER
51000-08102
CAPTIVE SCREW
INTERNAL BATTERY
56000-50010
QUICK-DISCONNECT
TERMINALS
+
–

INTERNAL BATTERY

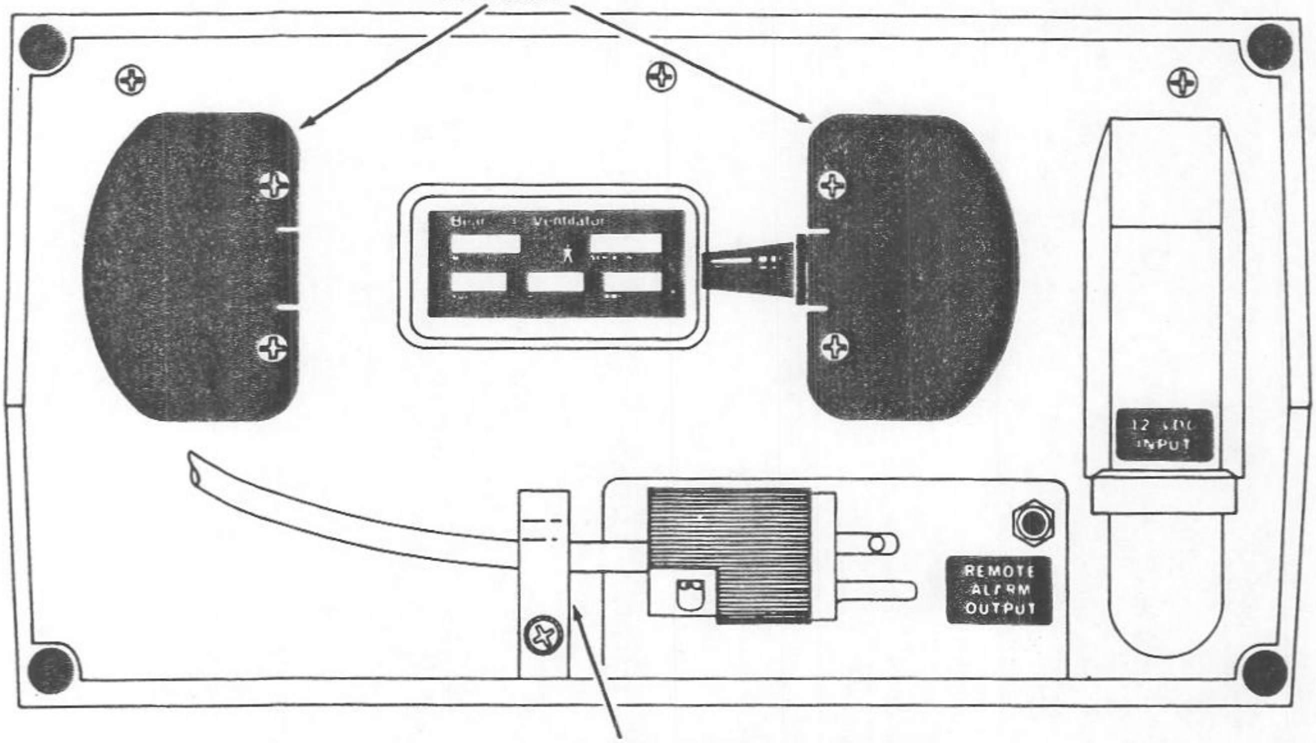

FUSE
AUTOMOBILE LIGHTER
ADAPTER ASSY.
51000-08128
POSITIVE
NEGATIVE

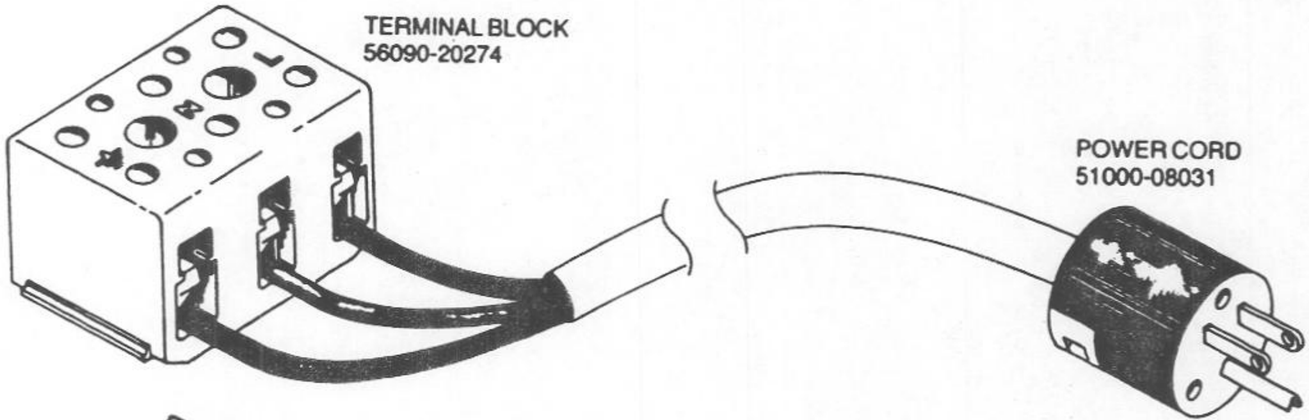
EXTERNAL BATTERY CABLE ASSY.
51000-08126

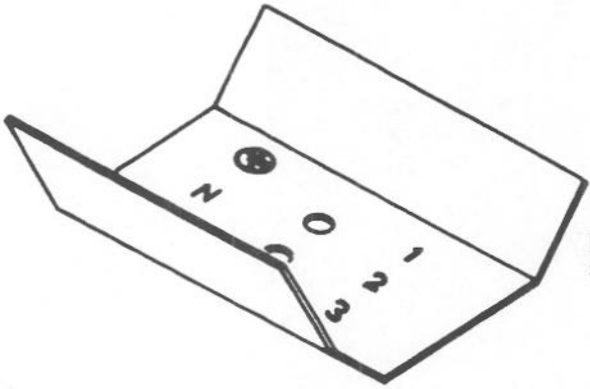


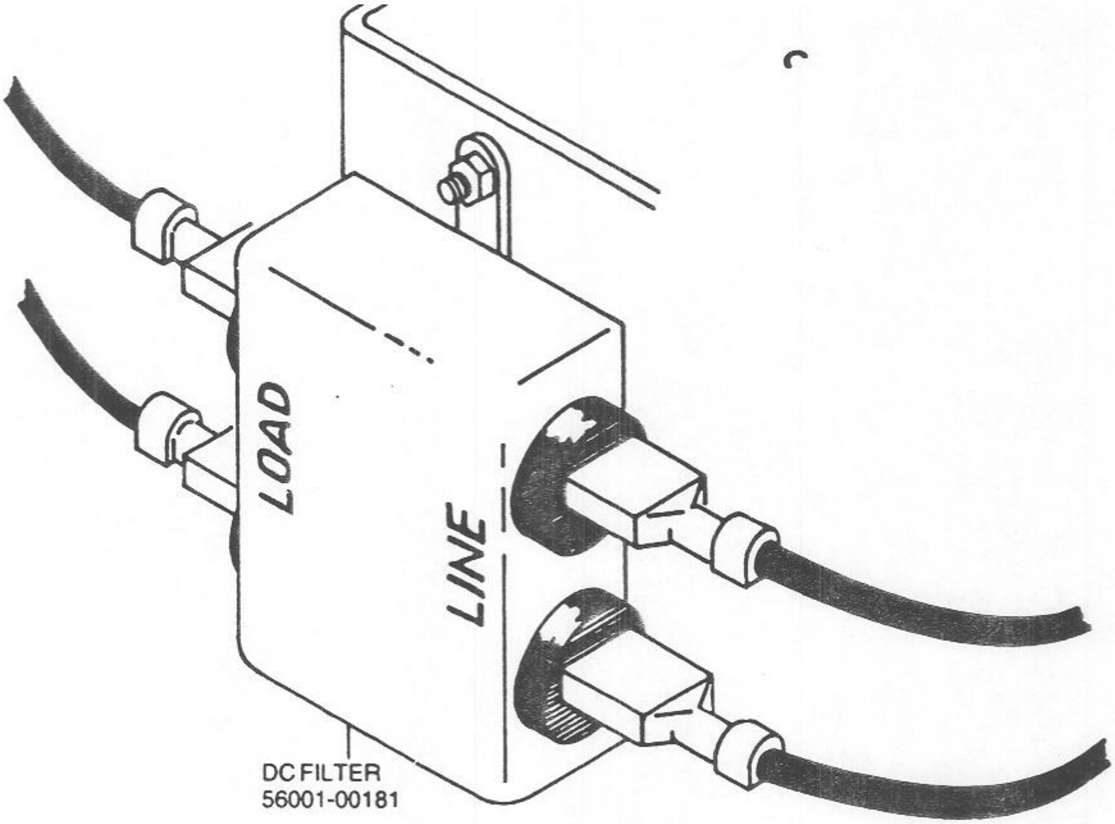
REMOTE (SONALERT) ALARM ASSY.
51000-08130

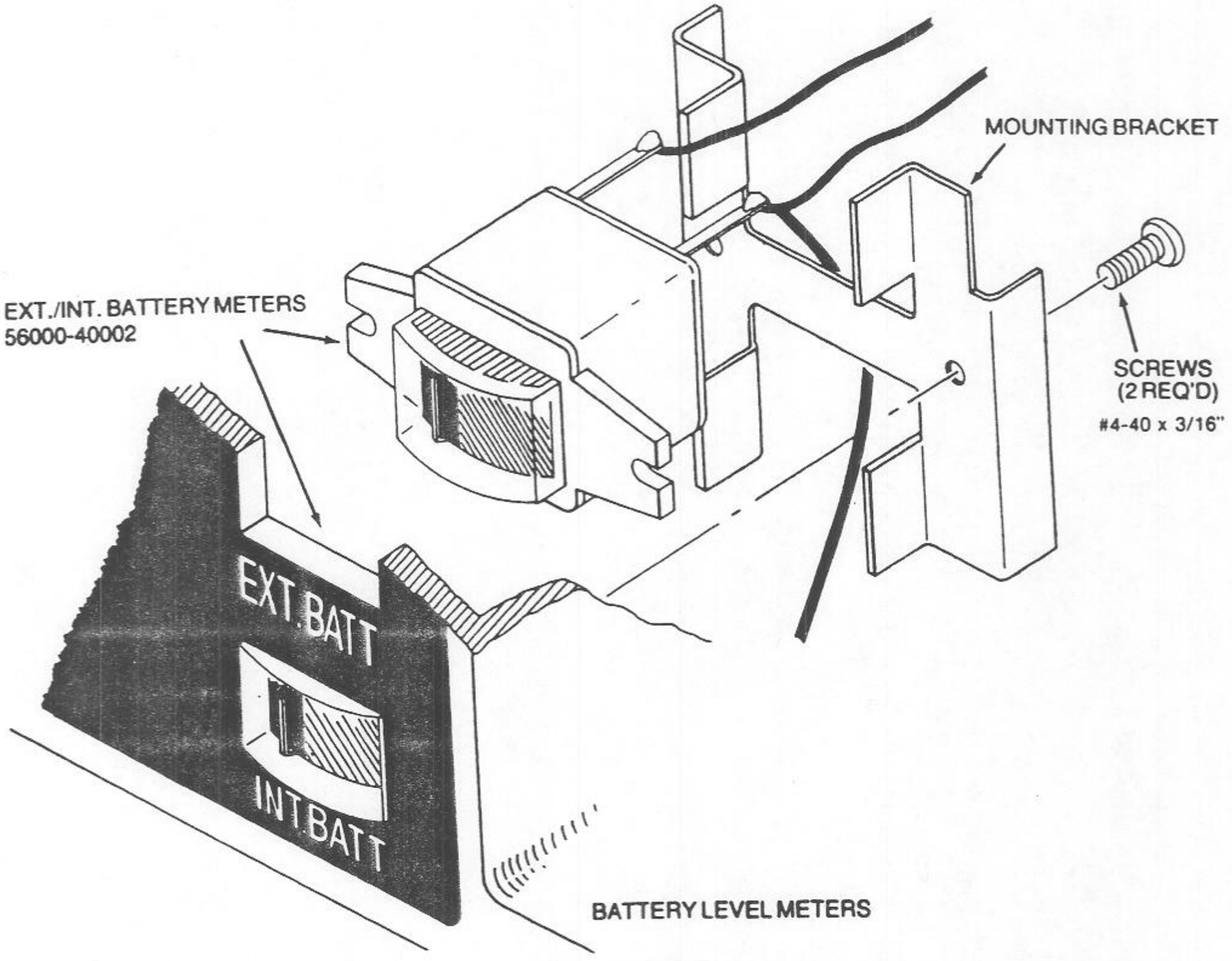
REMOTE (40 FEET) ALARM CABLE
56090-10088


POWER CORD RETAINER
51000-08087
12 VDC
INPUT
REMOTE
ALARM
OUTPUT
POWER PLUG RETAINER
51000-08137

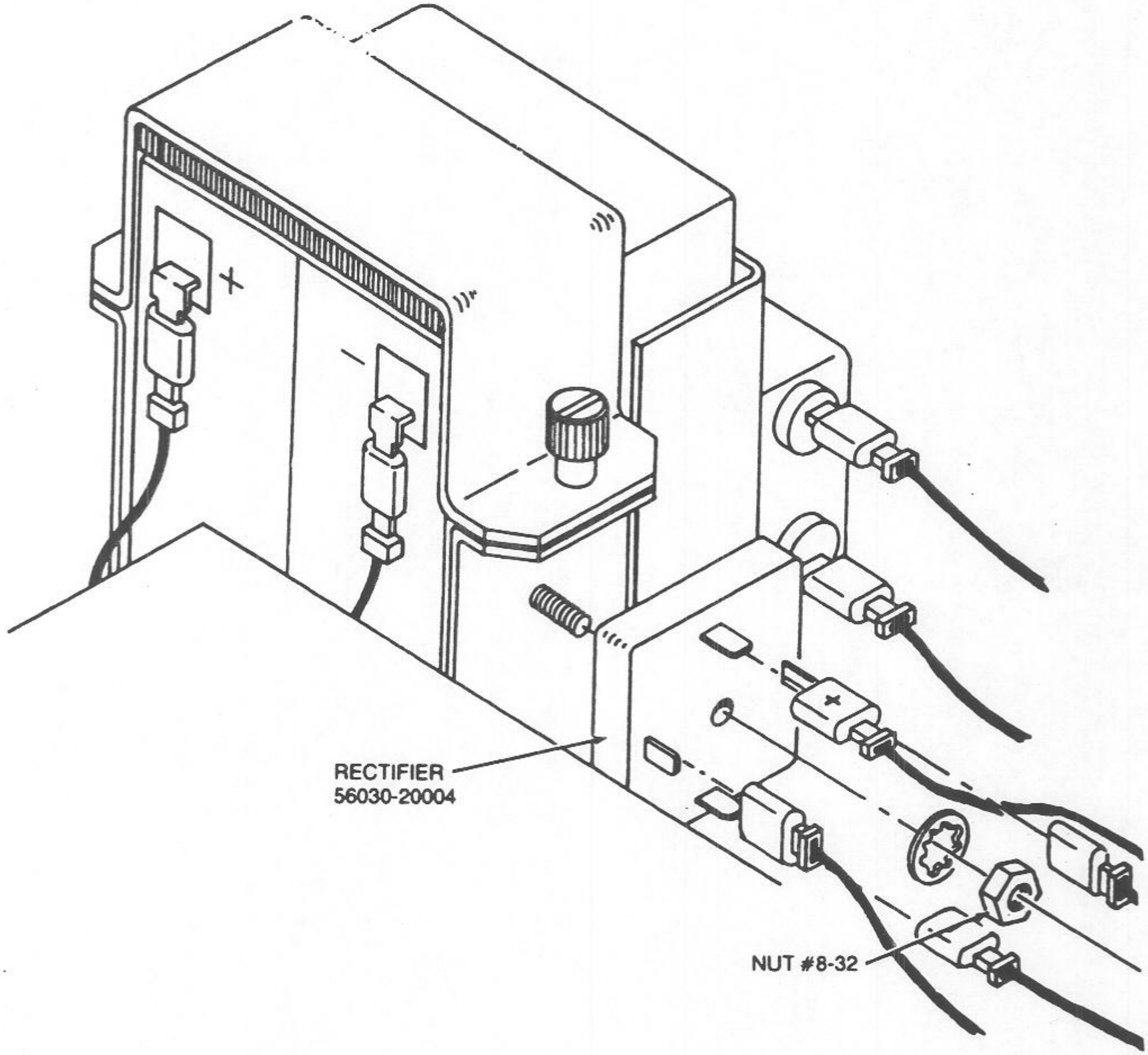

TERMINAL BLOCK
56090-20274
POWER CORD
51000-08031


N
1
2
3
DIELECTRIC SHIELD
51000-08125


LOAD
LINE
DC FILTER
56001-00181

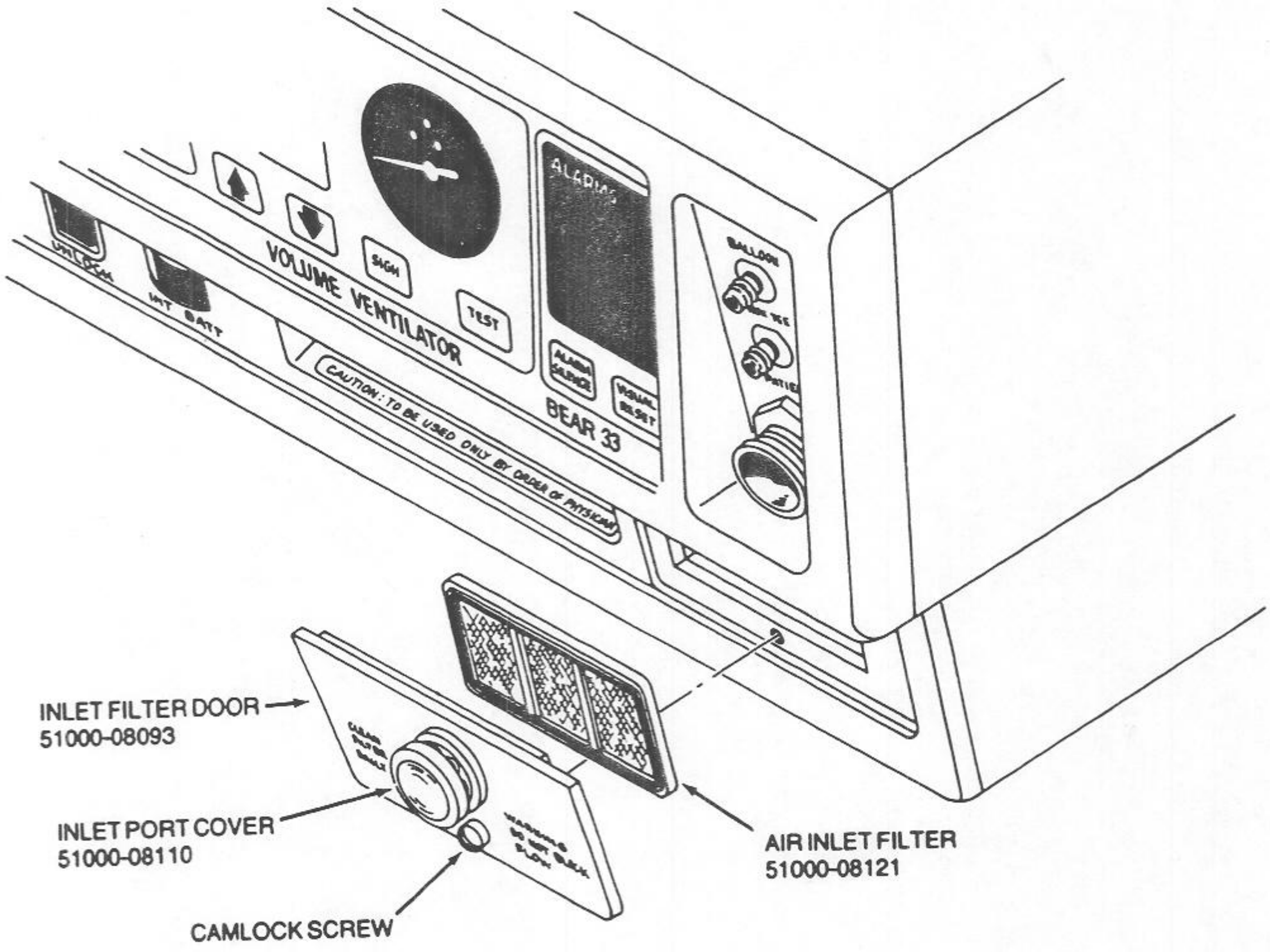

MOUNTING BRACKET
EXT./INT. BATTERY METERS
56000-40002
SCREWS
(2 REQ'D)
#4-40 x 3/16"
EXT. BATT
INT. BATT

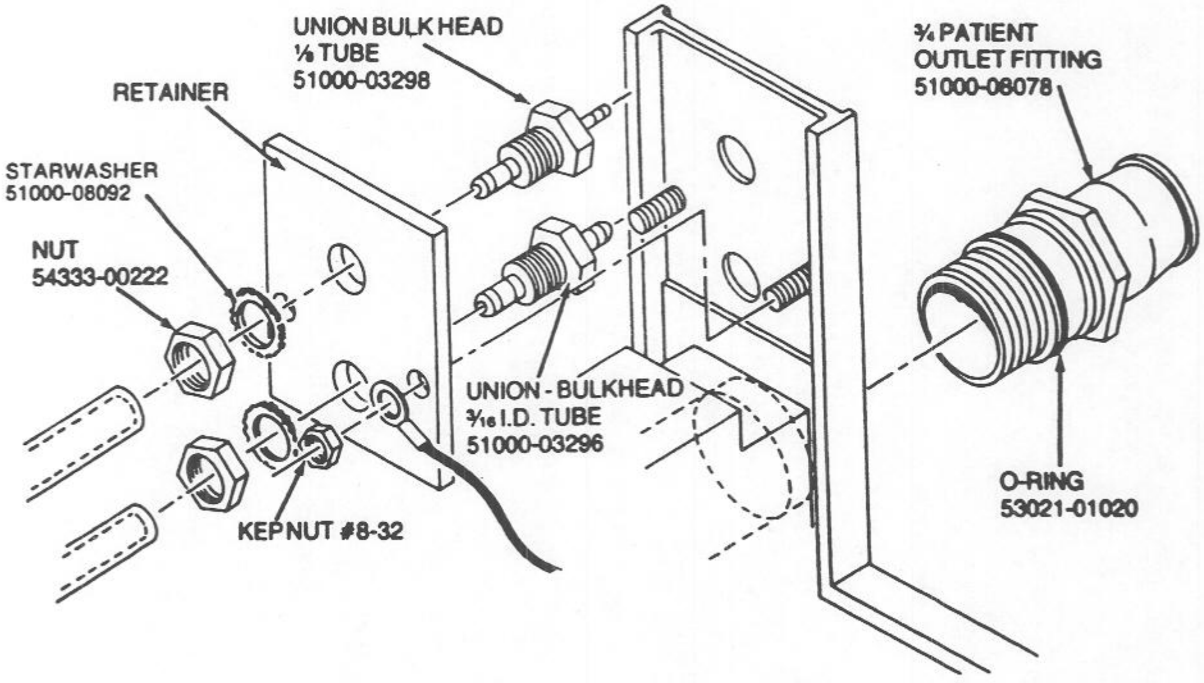
BATTERY LEVEL METERS



+
–
+
RECTIFIER
56030-20004
NUT #8-32

135


VOLUME VENTILATOR
SIGH
TEST
ALARMS
ALARM SILENCE
VISUAL RESET
BEAR 33
CAUTION: TO BE USED ONLY BY ORDER OF PHYSICIAN
UNLOCK
INT BATT
BALLOON
PATIENT
CLEAN FILTER DAILY
WARNING DO NOT BLOCK FLOW
INLET FILTER DOOR
51000-08093
INLET PORT COVER
51000-08110
CAMLOCK SCREW
AIR INLET FILTER
51000-08121


UNION BULK HEAD
⅛ TUBE
51000-03298
RETAINER
STARWASHER
51000-08092
NUT
54333-00222
KEPNUT #8-32
UNION - BULKHEAD
3/16 I.D. TUBE
51000-03296
¾ PATIENT
OUTLET FITTING
51000-08078
O-RING
53021-01020

EXH/PROX FITTINGS

SECTION 11

BEAR® 33 VOLUME VENTILATOR REPACKING AND SHIPPING INSTRUCTIONS

General

Bear Medical Systems,Inc., does not assume any liability whatsoever for any damage incurred in any product returned to our facilities by any means. The shipper and carrier are totally responsible for all damage and costs involved in transporting returned goods. If a package is damaged in shipment, your shipper and/or carrier should be notified within ten days of receipt of the shipment.

Packaging Instructions

1. Slip a plastic bag over the unit to minimize surface abrasion and keep dirt and packing materials out of the unit.
2. Place the unit in a sturdy carton, surrounded by an appropriate shock-absorbing packing material.
3. Place a shipper inside the carton.
4. Seal the carton with heavy duty shipping tape.

NOTE

It is highly recommended that packing be performed by a qualified properly equipped shipping department or a commercial packaging firm. Some local freight companies will pack the unit at your facility for a nominal service charge.